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SECURITY INFORMATION



BUREAU OF NAVAL PERSONNEL TECHNICAL BULLETIN 53-3

Guided Missile Personnel Research: Report No. 3

# A PROFICIENCY TEST BATTERY FOR GUIDED MISSILE TECHNICIANS

## Appendices

Prepared under the Sponsorship of the

BUREAU OF NAVAL PERSONNEL

ROBERT GLASER, Project Director

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AMERICAN INSTITUTE for RESEARCH

PITTSBURGH, PENNSYLVANIA

— SECURITY INFORMATION

# BUREAU OF NAVAL PERSONNEL

* RESEARCH REPORT *

Guided Missile Personnel Research: Report No. 3

## A PROFICIENCY TEST BATTERY FOR GUIDED MISSILE TECHNICIANS

Appendices

by

Robert Glaser, Project Director
Jack Kahn
John C. Phillips

American Institute for Research
Pittsburgh, Pennsylvania

August 1953

Prepared under Contract N7onr-37008, NR-152-079

TRAINING RESEARCH BRANCH AND
BILLET AND QUALIFICATIONS RESEARCH BRANCH,
PERSONNEL ANALYSIS DIVISION

50

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## A PROFICIENCY TEST BATTERY FOR GUIDED MISSILE TECHNICIANS

### Appendices

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# PROFICIENCY EXAMINATION
# TERRIER MISSILE
## TESTING AND ADJUSTMENT : PART A
### EXPERIMENTAL FORM P-2

PREPARED UNDER THE SPONSORSHIP OF THE
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CONTRACT NUMBER N7onr-37008, NR-152-079

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PITTSBURGH, PENNSYLVANIA

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SECURITY INFORMATION

## GENERAL DIRECTIONS: TESTING AND ADJUSTMENT, PART A

This is a test of your knowledge of the procedures involved in testing and adjusting the TERRIER missile and its associated test and servicing equipment.

You will be asked questions about:

The steps to be taken during a testing and adjustment procedure

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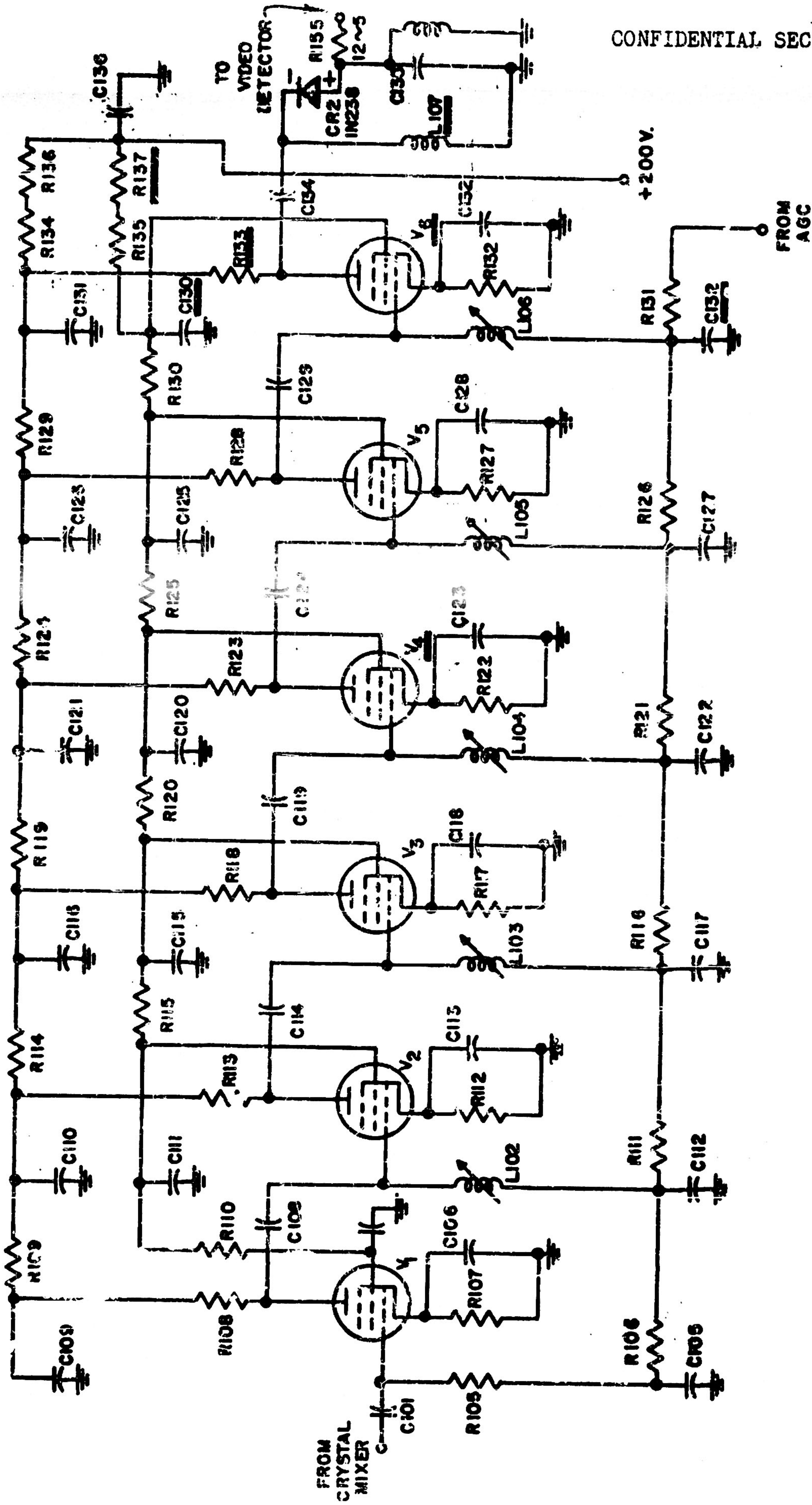
Make no marks on the test booklet. Scratch paper is supplied for you to use in making any drawings or computations you think necessary. Do not turn the next page until you are instructed to do so.

# RECEIVER

PLEASE NOTE: ALL ITEMS IN THE RECEIVER SECTION REFER TO THE SUPERHETERODYNE RECEIVER.




SCHEMATIC DIAGRAM I.F. STRIP

1. While a TERRIER receiver is in a missile, a check on its sensitivity may be made most rapidly by using which of the following combinations of testing units?

   1. A 45 mc. oscillator and a vacuum tube voltmeter.
   2. The Radar Beam Simulator and the Monitoring Panel.
   3. The Flight Ready Indicator and the Guidance Analyzer.
   4. The BuOrd Functional Test Equipment and a synchroscope.

2. After installing a new klystron local oscillator in TERRIER, the first step in tuning the new oscillator and AFC System is which one of the following?

   1. Turn the "AFC on-off" switch to OFF.
   2. Turn the "AFC on-off" switch to ON.
   3. Operate the "Reflector Voltage Adjustment" to obtain maximum "Crystal Detector Current".
   4. Operate the "Klystron cavity tuning adjustment" to obtain maximum AGC voltage.

3. In aligning the second triple of the TERRIER receiver I.F. strip, (see diagram on opposite page) the band pass is found to be 6.5 mc. To obtain the 7.4 mc. band pass required, which one of the following should be done?

   1. Decrease R-133
   2. Increase R-133
   3. Compress L-107
   4. Elongate L-107

GUIDANCE SYSTEM

4. In order to align the Roll Stabilization system, the first step is to:

   1. balance the phase comparator.
   2. adjust the Roll amplitude potentiometer on the Monitoring Panel.
   3. adjust the Rolleron trim potentiometers.
   4. check the Roll Corrector synchro armature position.

5. After replacing the Roll Corrector package, a missile systems test is run using the Monitoring Panel. Testing proceeds satisfactorily up to the part of the test concerning the Roll System. It is found that although rolleron trim, speed and sensitivity are within tolerance limits, the direction of roll correction is 180° out of phase with roll error.
To eliminate the trouble, the correct procedure is to:

   1. replace the Guidance Package.
   2. readjust the Roll Free Gyro.
   3. adjust the phasing potentiometers of the intelligence converter.
   4. reverse the $S_1$ and $S_3$ leads between the Gyro Pick-off synchro and the Roll Corrector synchro.

6. The proper orientation of the rotor of the missile's Roll Corrector Synchro is to be checked. The missile is set in the launch position on the roll stand; the missile operate relay is actuated; and the missile is rolled C.C.W. 67-1/2°. The Monitoring Panel indications should be:

| | Rolleron Protractor Reading | Roll Free Gyro |
|---|---|---|
| 1. | -20° | 0.0 V |
| 2. | 0° | 0.0 V |
| 3. | 0° | 10.0 V |
| 4. | +20° | 10.0 V |

7. Each of the following lists contains four operations (checks or adjustments) which must be performed during a Monitoring Panel test of the guidance system.
Which list indicates the correct sequence of performing these operations?

1. a. Computer and wing limits checks
   b. Integral response check
   c. Wing trim adjustments
   d. Wing speed check

2. a. Integral response check
   b. Wing trim adjustments
   c. Wing speed check
   d. Computer and wing limits checks

3. a. Wing speed check
   b. Computer and wing limits checks
   c. Integral response check
   d. Wing trim adjustments

4. a. Wing trim adjustments
   b. Wing speed check
   c. Computer and wing limits checks
   d. Integral response check

8. In the final adjustment of the Intelligence Converter phasing potentiometers, the correct programmer time setting and signal input are:

   1. Programmer at 10 seconds, radar or beam simulator at 6 db error and -15 dbm range.
   2. Programmer at 3.0 seconds, radar or beam simulator at 6 db error and -15 dbm range.
   3. Programmer at 10 seconds, 30 cps reference and error signals from Monitoring Panel to missile.
   4. Programmer at 3 seconds, 30 cps reference and error signals from Monitoring Panel to missile.

# ELECTRICAL SYSTEM
# (POWER SUPPLY AND SWITCHING)

Three steps are involved in the procedure for adjusting the outputs of the regulated power supplies.

**9.** The first step is:

1. Adjust the positive supply to +200 volts.
2. Adjust the negative supply to -200 volts.
3. Check the alternator output frequency.
4. Check the alternator voltage.

**10.** The second step is:

1. Adjust the positive supply to +200 volts.
2. Adjust the negative supply to -200 volts.
3. Check the alternator output frequency.
4. Adjust the difference voltage to ± 0.2 volts.

**11.** The third step is:

1. Adjust the positive supply to +200 volts.
2. Adjust the negative supply to -200 volts.
3. Check the per cent ripple in both supplies.
4. Adjust the difference voltage to ± 0.2 volts.

12. When checking the missile regulated power supply with the Monitoring Panel, the following results are recorded:

| Function Tested | Panel Reading | Limits |
|---|---|---|
| +200 Volts | +201.2 V | +198 to+202 V |
| -200 Volts | -200.0 V | -198 to -202 V |
| Difference Voltage ±200 V | +1.2 V | ±0.2 V |

In order to bring the voltage values within specified limits, the technician should:

1. replace the power supply package.
2. replace the primary reference voltage regulator tubes.
3. adjust the negative reference calibration potentiometer.
4. adjust the positive reference calibration potentiometer.

13. When checking the missile regulated power supply with the Monitoring Panel, the following results are recorded:

| Function Tested | Panel Reading | Limits |
|---|---|---|
| +200 Volts | +207.1 V | +198 to+202 V |
| -200 Volts | -207.0 V | -198 to -202 V |
| Difference Voltage ±200 V | +0.1 V | ±0.2 V |

In order to bring the voltage values within specified limits, the technician should:

1. replace the power supply package.
2. replace the primary reference voltage regulator tubes.
3. adjust the negative reference calibration potentiometer.
4. adjust the positive reference calibration potentiometer.

# AIR AND HYDRAULIC SYSTEM

14. While a missile air bottle is being charged, the autopac is kept from cycling by:

1. a cap on the air exhaust port.
2. an adjustment of the air pressure regulator.
3. a check valve in the external air connection.
4. the position of the air shut off valve.

15. When the sections of a missile are assembled the hydraulic couplings are connected:

1. by screwing together pipe unions on each coupling before the missile sections are mated.
2. by screwing together pipe unions on each coupling after the missile sections are mated.
3. automatically, as the dust caps are punctured by mating the missile sections together.
4. automatically, after the dust caps have been removed. by mating the missile sections together.

# GENERAL MISSILE SYSTEM

16. The phasing control of the Beam Simulator is used to inject a "Left Down" (45° from horizontal) error signal into a missile under test. Which of the following should move if the missile is operating properly?

1. A wings
2. B wings
3. Both A and B wings
4. Rollerons

17. During certain test operations using the Monitoring Panel, it is necessary to close the oil shut-off valve on the hydraulic motor.
If this valve were left open:

1. oil would leak from the hydraulic motor housing.
2. the regulated 200 volt supplies would be over driven.
3. insufficient oil pressure would be available for driving the the hydraulic actuators.
4. the alternator would overheat and perhaps burn out.

18. When replacing vacuum tubes in missile components it is necessary to check new tubes by:

1. use of a standard emission checker; but rap tubes sharply with a mallet to detect microphonics.
2. use of a standard tube checker in conjunction with a high "g" tester.
3. running a missile systems test after replacement of the defective tube.
4. testing with a dynamic mutual conductance tube tester.

# HYDRAULIC CHARGING UNIT

19. An empty Hydraulic Charging Unit is to be used for charging new hydraulic oil into a missile which now contains hydraulic oil. The Charging Unit is set up as follows:

a. All valves, except the vacuum intake valve on the vacuum pump, are closed.

b. All switches are in the closed or "OFF" position.

c. The external air supply is connected and the air pressure regulator properly adjusted.

d. The Charging Unit is connected to an electrical power source.

Select the next sequence of operations to be performed.

1. Connect missile connection hose to fluid container, (Open filter bypass valve).
2. Open filter bypass valve, Connect missile connection hose to missile.
3. Connect missile connection hose to fluid container, Open air valve
4. Connect missile connection hose to missile, Open air valve.

20. While a missile is being evacuated by the Hydraulic Charging Unit the autopac is cycled and the servo reverse polarity switch actuated. After evacuation is completed, which sequence of operations correctly starts the missile charging procedure?

1. Turn off vacuum pump.
   Close vacuum valve.
   Open air valve.
   Close filter bypass valve.
2. Close vacuum valve.
   Open air valve.
   Turn off vacuum pump.
   Close filter bypass valve.
3. Close filter bypass valve.
   Close vacuum valve.
   Turn off vacuum pump.
   Open air valve.
4. Close filter bypass valve.
   Turn off vacuum pump.
   Open air valve.
   Close vacuum valve.

21. The release valve on the Hydraulic Charging Unit is opened and closed to release any vacuum or pressure trapped in the Charging Unit. This should be done in which of the following sequences:

1. adjust the temperature compensator; open and close the release valve; close the manifold poppet valve.
2. adjust the temperature compensator; close the manifold poppet valve; open and close the release valve.
3. open and close the release valve; adjust the temperature confensation; close the manifold poppet valve.
4. close the manifold poppet valve; open and close the release valve; adjust the temperature compensator.

22. Oil is filtered by circulating it within the Hydraulic Charging Unit. During this operation the pressures in the sump and reservoir should be:

1. high vacuum in the sump; high pressure in the reservoir.
2. high pressure in the sump; high pressure vacuum in the reservoir.
3. high vacuum in both sump and reservoir.
4. approximatic atmosphere pressure in both sump and reservoir.

# FLIGHT READY INDICATOR

OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |
| FLIGHT READY INDICATOR | | | |

23. Four partial results from a missile test with the Flight Ready Indicator are given below. Three of these results indicate possible malfunctioning of the Flight Ready Indicator; one indicates a possible missile fault. Select the one which is least likely to indicate malfunctioning of the Flight Ready Indicator.

| | Switch Position | Meter Indication |
|---|---|---|
| 1. | A | Meter A in tolerance |
| | D | " A out of tolerance |
| 2. | A | " A in " |
| | B | " A out of " |
| 3. | B | " B in " |
| | A | " B out of " |
| 4. | G | " A in " |
| | D | " A out of " |

24. When the Flight Ready Indicator is used, an auxiliary source of warm-up power is required. Which one of the following power sources, if it were used, would be most likely to cause damage to the missile?

1. 28 volts, 400 cps, single phase, grounded.
2. 115 volts, 400 cps, single phase, ungrounded.
3. 115 volts, 60 cps, 3 phase, y-connected grounded neutral.
4. 115 volts, 400 cps, 3 phase, y-connected grounded neutral.

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# PROFICIENCY EXAMINATION
# TERRIER MISSILE
## TESTING AND ADJUSTMENT : PART B
### EXPERIMENTAL FORM P-2

PREPARED UNDER THE SPONSORSHIP OF THE
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OFFICE OF NAVAL RESEARCH
CONTRACT NUMBER N7onr-37008,-NR-152-079

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PITTSBURGH, PENNSYLVANIA

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## GENERAL DIRECTIONS: TESTING AND ADJUSTMENT, PART B

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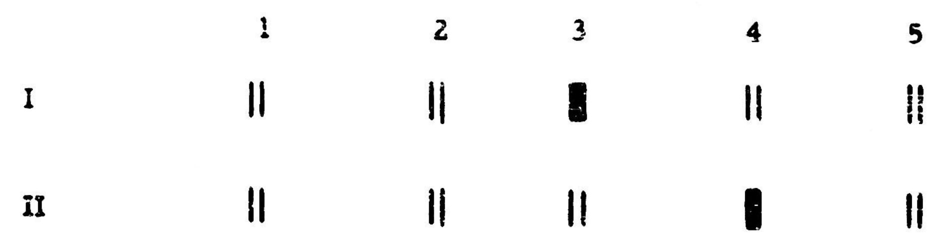


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# MONITORING PANEL

1. In order to calibrate a Brush Recorder for signal amplitude, which of the following instruments or combinations of instruments should be used?

   1. The Monitoring Panel oscilloscope.
   2. D.C. VTVM.
   3. A.C. VTVM.
   4. D.C. VTVM and the Monitoring Panel oscilloscope.

2. In order to check the roll rate change of the roll stabilization system, it is necessary to accurately calibrate the Graham drive for frequencies of 0.1 cps and 5 cps.
This can be done by using:

   1. the Monitoring Panel oscilloscope.
   2. the Graham drive vernier dial.
   3. the Monitoring Panel frequency meter.
   4. the Brush recorder.

3. It is desired to check the static linearity of the Monitoring Panel D.C. amplifiers and Brush recorders. The signal sources and instruments used for this check are:

   1. a square wave generator and the Monitoring Panel Brush recorder.
   2. the Monitoring Panel electronic chassis internal voltages and the Monitoring Panel VTVM.
   3. the output of Monitoring Panel sine wave pot and the Monitoring Panel oscilloscope.
   4. an audio oscillator and a distortion analyzer.

4. In setting up a missile for a missile systems test using the Monitoring Panel, protractors are substituted for one rolleron and each wing. The next step after installation of the protractors is to:

1. install the external air supply fittings.
2. manually center the protractor indicators with respect to activator stops.
3. adjust the wing and rolleron trim pots to center protractor indicators.
4. make cable connections between panel and missile.

5. In checking the Monitoring Panel, the following readings are obtained from the electronic chassis meter:

| Switch Position | Reading | Normal Voltage |
|---|---|---|
| 1 | -235 V | -250 V |
| 2 | +301 V | +300 V |

In order to bring these readings into tolerance, the correct procedure is to:

1. adjust the negative supply regulating potentiometer.
2. adjust the positive supply regulating potentiometer.
3. first adjust the positive, then the negative supply regulating potentiometers.
4. first adjust the negative, then the positive supply regulating potentiometers.

| Test | Conditions of Test | Signal Checked | Readings Obtained | Specified Limits |
|---|---|---|---|---|
| Rolleron Trim Adjustment | Ground servo amp. input. Adjust trim pot. | Rolleron position | $0^{\circ}$ center backlash | $0^{\circ}$ center backlash |
| Rolleron Speed Check | 4.5V D.C. step signal to input roll servo amp. | Record of Rolleron position | No rolleron motion | Max. speed $200^{\circ}$ per sec. |
| Roll Sensitivity | Roll Missile<br>$20^{\circ}$ CCW<br>$10^{\circ}$ CCW<br>Pull Sepn lanyard<br>Roll Missile<br>$30^{\circ}$ CCW | Rolleron position | Normal<br>Normal<br>Normal<br><br>Normal | $0^{\circ}$ to $0.9^{\circ}$<br>$1.1^{\circ}$ to $3.4^{\circ}$<br>$4.6^{\circ}$ to $13.4^{\circ}$<br><br>$4.6^{\circ}$ to $13.4^{\circ}$ |
| Roll Dynamic Sensitivity | D.C. signal to input servo amp. at a sine rate of 0.1 cps and 5.0 cps. | Record peak to peak roll-eron angle at both fre-quencies. Compute gain ratio. | Gain ratio 1.7 | Gain ratio 1.2 to 1.8 |

6. A missile which has passed the FRI check successfully is given a missile systems test using the Monitoring Panel. Partial results of the missile systems test are given above with the out-of-tolerance reading encircled. All other portions of the test are passed successfully. Referring to the test results given above and to the FRI Operating Instructions shown on the opposite page, determine the next step to be taken.

1. Replace the missile roll corrector.
2. Replace the missile guidance package.
3. Check the Monitoring Panel with the set up Monitoring Panel Test Unit.
4. Trouble-shoot the FRI.

OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
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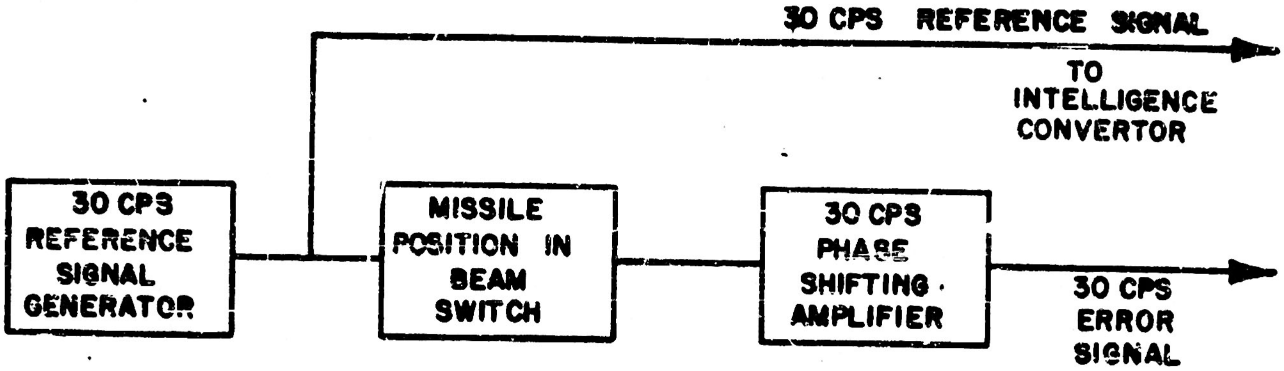
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |

FLIGHT READY INDICATOR




MONITORING PANEL 30 CPS SIGNAL GENERATOR SECTION

7. As a result of a missile systems test using the Monitoring Panel, it is suspected that the 30 cps phase shifting amplifier shown in the above block diagram is incorrectly calibrated. In order to check the phase of the amplifier output voltage, which of the following combinations of signal source and test instrument should be used?

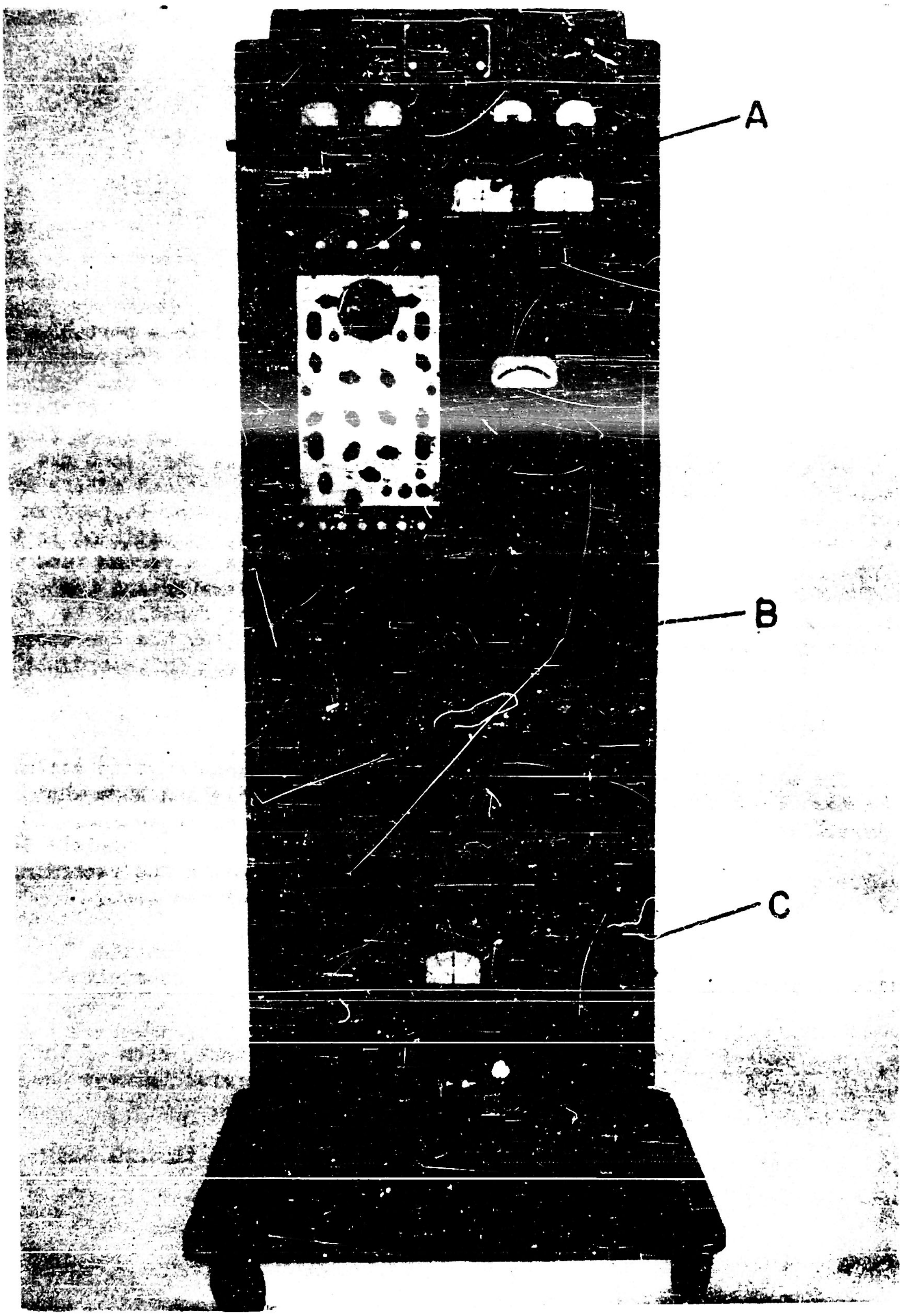
| | Signal Source | Test Instrument |
|---|---|---|
| 1. | M.P. 30 cps reference generator | Oscilloscope |
| 2. | Audio oscillator | Spectrum Analyzer |
| 3. | Audio oscillator | Headphones |
| 4. | M.P. 30 cps reference generator | VTVM |

8. When readying the Monitoring Panel for a missile systems test, the VTVM should be zeroed. The first step in this procedure is to:

   1. adjust the meter reading to Zero with the panel "Zero Control."
   2. short out the "Open Grid" D.C. terminals.
   3. short circuit the meter's A.C. terminals and check for Zero reading.
   4. adjust the meter indicator to Zero with Panel Power OFF.

9. External power is applied to the missile through the Monitoring Panel. The phase rotation test lamps indicate reverse phase rotation. To correct this difficulty, the procedure is to:

   1. turn a switch on the Monitoring Panel which will provide proper phasing.
   2. change the power output leads at the motor generator.
   3. change the direction of rotation of the motor generator.
   4. reverse the field leads on the generator.

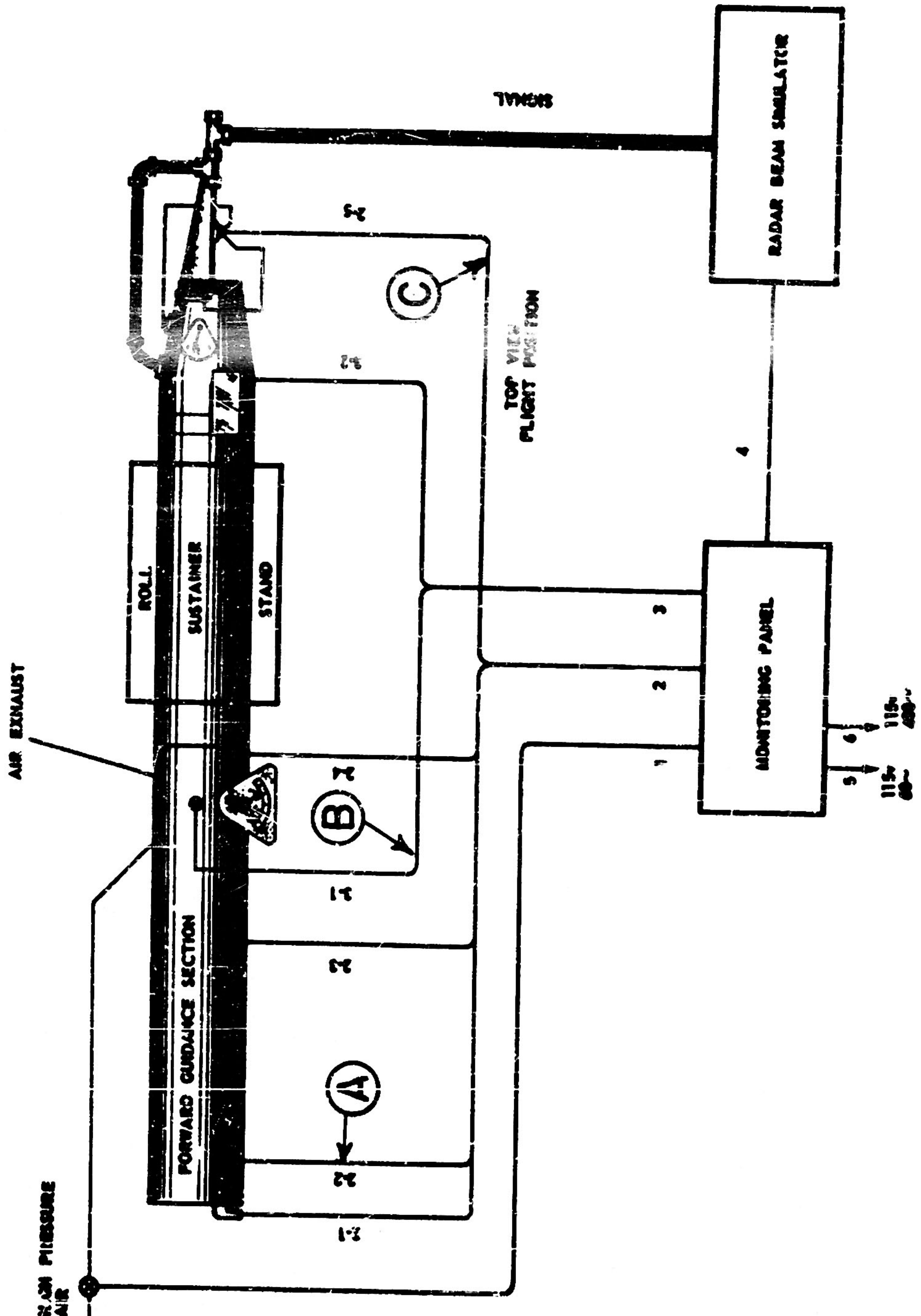

A
B
C

In the picture of the Set-Up Monitoring Panel shown on the opposite page, three different sections are labeled A, B, and C respectively. Identify these sections.

10. Section A
    1. Running time meter.
    2. Programmer position meter.
    3. A.C. ammeter.
    4. Valve current meter.

11. Section B
    1. Valve test section.
    2. Input signal section.
    3. Recorder selection panel.
    4. Missile control section.

12. Section C
    1. Electronic chassis.
    2. Beam simulator
    3. Sine wave chassis.
    4. Recorder chassis.


RADAR BEAM SIMULATOR
SIGNAL
TOP VIEW FLIGHT POSITION
MONITORING PANEL
ROLL
SUSTAINER
STAND
AIR EXHAUST
FORWARD GUIDANCE SECTION
RAM PRESSURE AIR
A
B
C

The diagram on the opposite page indicates the correct cable connections between the Monitoring Panel and the missile for a missile systems test. Select from each of the three groups of cables listed below, the ones corresponding to the letters (A), (B), and (C) on the diagram.

13. Cable (A)

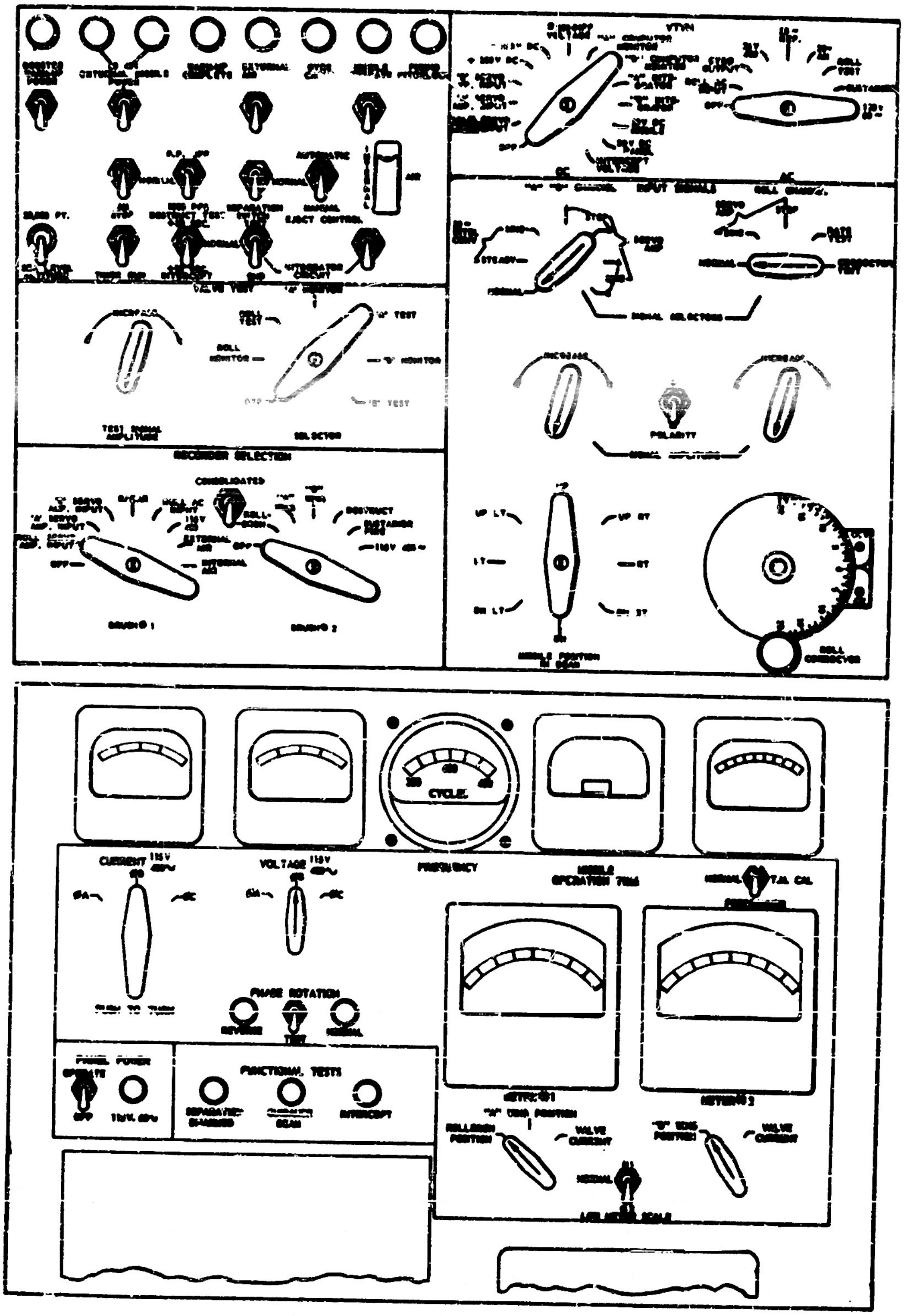
1. Booster warm-up and separation switch cable
2. Roll correction patch
3. Warhead and fuse cable
4. Receiver cable

14. Cable (B)

1. Roll corrector patch
2. Guidance package patch
3. Sustainer squib cable
4. Test plug cable

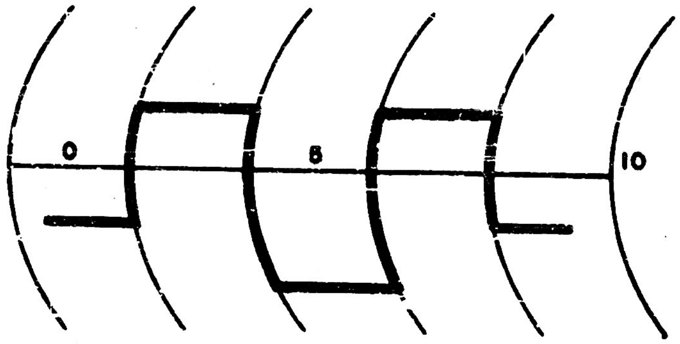
15. Cable (C)

1. Booster warm-up and separation switch cable
2. Beam simulator control
3. Receiver cable
4. Backscratcher cable


RECORDER SELECTION
CONSOLIDATED
SELECTOR
POLARITY
CYCLE
CURRENT
VOLTAGE
FREQUENCY
PHASE ROTATION
FUNCTIONAL TESTS
INTERCEPT

16. It is desired to determine the maximum rate of rolleron motion as part of a missile systems test. A 4.5 volt D.C. step signal is to be applied to the input of the roll servo amplifier. The changes of rolleron position are to be recorded and the maximum rate computed.
Which of the following combinations of switch positions must be used to run this test? (Refer to Panel Switch Arrangement on opposite page.)

| | VTVM D.C. | VTVM A.C. | "A" & "B" Channel | Roll Channel | Brush #1 | Brush #2 |
|---|---|---|---|---|---|---|
| 1. | Off | Roll A.C. input | Normal | Rate Test | Roll A.C. input | Rolleron |
| 2. | Roll Servo amp input | Off | Normal | Servo amp step | Roll Servo amp input | Rolleron |
| 3. | Roll Servo amp input | Off | Servo amp "B" step | Servo amp step | Off | Rolleron |
| 4. | Off | Roll A.C. input | Servo amp "A" Step | Rate Test | Off | Rolleron |




17. For the Rolleron speed check of the missile systems test using the Monitoring Panel, a 4.5 volt step signal is fed into the roll servo amplifier. The recorded signal from the rolleron position potentiometer is shown above. The record indicates that the technician should:

1. balance the Monitoring Panel sine potentiometer supply to ground.
2. position the Monitoring Panel "Roll Corrector" dial to zero.
3. adjust the "output zero" of the D.C. amplifier.
4. increase the gain of the Monitoring Panel demodulator.

# GUIDANCE ANALYZER

18. In adjusting the PRF Generator on the Decoder chassis, the following steps are performed in the order given:

1. Place Use Cal switch on the Decoder Panel in the Cal position
2. Turn the Pulse Ampl control fully clockwise
3. Turn the PRF-FM switch on the Decoder Panel to the PRF position

The fourth step is which of the following?

1. Hold the Meter Adjust switch down and zero the meter with the Meter Zero control.
2. Hold the Meter Adjust switch down and center the meter with the Meter Center control.
3. Release the Meter Adjust switch and read the PRF scale on the meter.
4. Release the Meter Adjust switch and read the FM Duration scale on the meter.

19. The synchroscope in the guidance analyzer is not used to make which one of the following measurements on the radar beam?

1. Shape and amplitude of individual pulses.
2. Separation between coded pulses.
3. DB modulation measurements.
4. Power level measurements.

20. The phase angle between the reference and error voltages produced in the Guidance Analyzer may be varied by turning the phase dial on the 30 cycle Reference Generator panel. As the phase dial is turned, a change occurs in

1. the frequency of a heterodyne oscillator.
2. the capacitance in an RC phase shift circuit.
3. the resistance in an RC phase shift.
4. the frame position of one of a pair of rotating generators.

21. After the Guidance Analyzer has been allowed to warm up for a few minutes, a plate voltage check gives the following data:

| Meter Switch Position | Meter Indication |
|---|---|
| -200 | -190 |
| +110 | +110 |
| +200 | +200 |
| +250 | +250 |

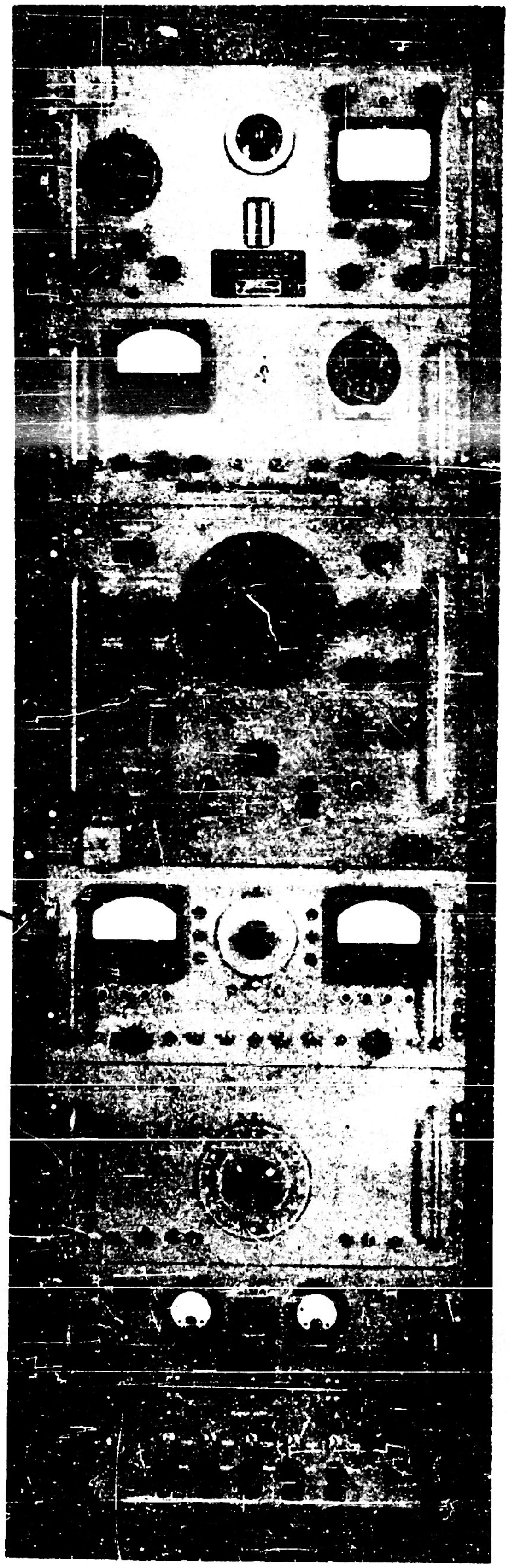
What should the next step be?

1. Replace the -200 volt regulator tube.
2. Replace the -200 volt rectifier tube.
3. Change the Adjust to Line Voltage rotary switch.
4. Make a potentiometer adjustment.

22. Certain sections of the Guidance Analyzer should be recalibrated more frequently than other sections. The sections used in making which one of the following measurements should be rechecked most frequently for a given period of use?

1. Frequency measurement
2. Pulse repetition rate
3. Power level measurement
4. Pulse duration measurement

A



23. The Adjust to Line Voltage rotary switch on the Guidance Analyzer is left on the 125 volt position when the line meter indicates 115 volts. Which of the following statements best describes the power supply output voltage condition?

1. Only the 6 volt outputs would be high
2. All output voltages would be high
3. Only the 6 volt outputs would be low
4. All output voltages would be low

24. The Guidance Analyzer reference generator panel is used in the measurement of which of the following?

1. R.F. power level
2. Phase measurement
3. Error signal modulation
4. Pulse repetition frequency

25. In the picture of the guidance analyzer shown on the opposite page the panel marked A is which one of the following?

1. Power supply panel
2. Reference generator panel
3. Comparator panel
4. Decoder panel

26. When checking the frequency of the Beam Simulator, with the Guidance Analyzer, two dips are observed on the VTVM as the wavemeter is tuned through the frequency range. The Beam Simulator frequency may be determined by the dip that is associated with which of the following conditions?

1. The higher frequency
2. The lower frequency
3. A change in crystal current
4. No change in crystal current

CONFIDENTIAL-
SECURITY INFORMATION

# PROFICIENCY EXAMINATION
# TERRIER MISSILE
## TROUBLE-SHOOTING : PART A
### EXPERIMENTAL FORM T-2

PREPARED UNDER THE SPONSORSHIP OF THE
BUREAU OF NAVAL PERSONNEL

OFFICE OF NAVAL RESEARCH
CONTRACT NUMBER N7onr-37008, NR-152-079

AMERICAN INSTITUTE FOR RESEARCH
PITTSBURGH, PENNSYLVANIA

CONFIDENTIAL-
SECURITY INFORMATION

## GENERAL DIRECTIONS: TROUBLE SHOOTING, PART A

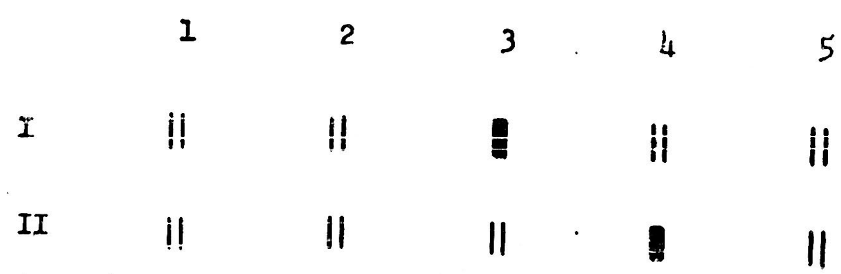
This is a test of your ability to locate a defective component when you are given a description of the faulty operation of a TERRIER missile, or of its associated test or servicing equipment.

Most of the questions in this test describe a faulty condition and ask you to identify the component which could cause this condition. Other questions describe a faulty condition or operation and ask you to identify one component which could not cause the condition. Read each question carefully.

Most of the test questions cannot be answered from memory. They require you to think carefully about the problem before you decide on the correct answer. In taking the test you will need to pay special attention to the diagrams which accompany the questions.

Be sure to answer every question in the test, but do not spend too much time on any one problem. Some of the questions are more difficult than others; if you are not completely sure of the correct answer to a problem, make the best guess you can and go on to the next one.

The examiner will instruct you how to fill out the enclosed answer sheet. When doing this print all information that is required. Mark your answers to the problems in this test on this answer sheet. For each question, heavily blacken the space which has the same number as the answer you select, as shown below:



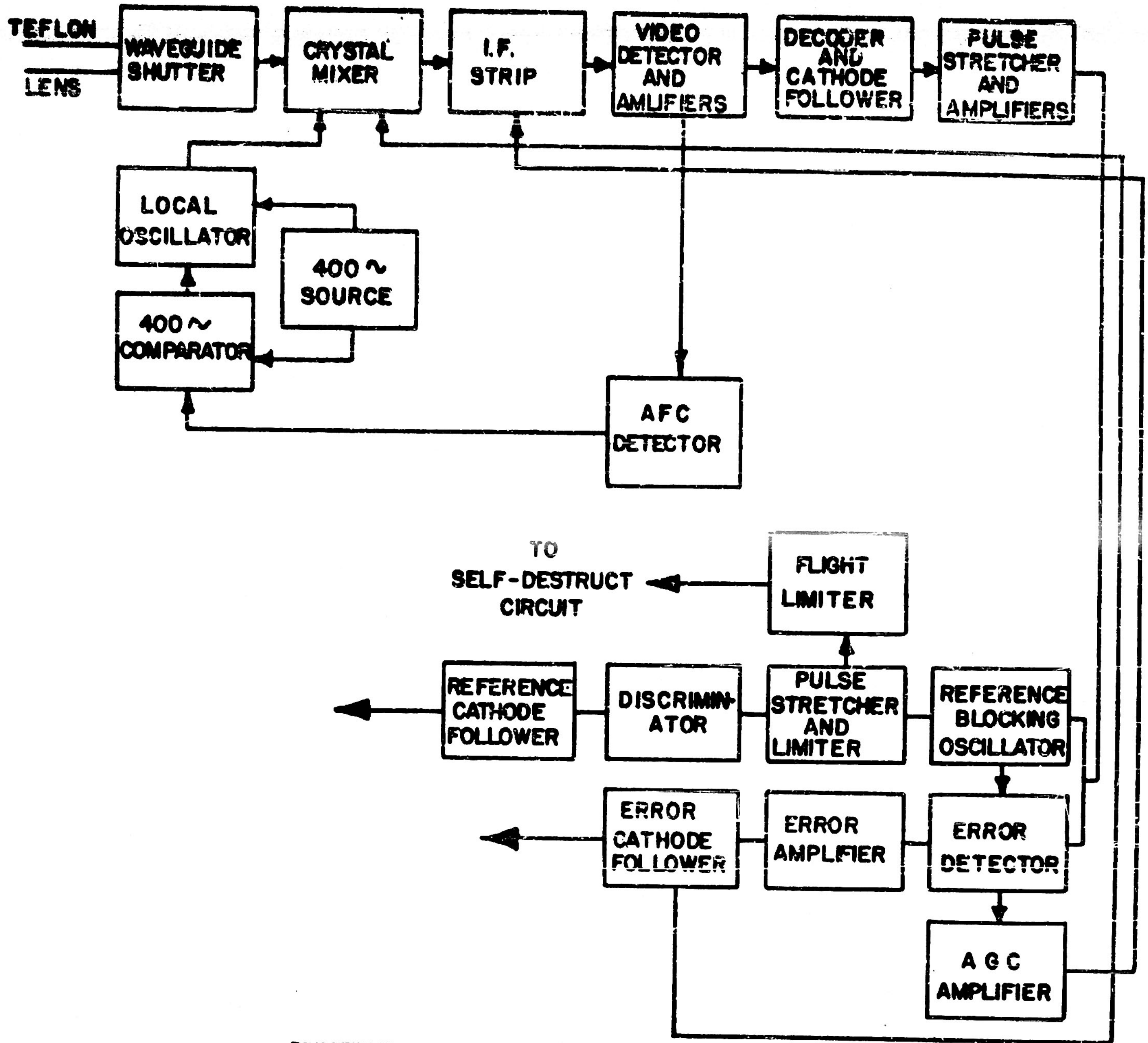

In this example, Answer 3 is marked as being correct for problem I and Answer 4 is marked as being correct for problem II. Mark only one answer for each problem. If you mark two or more answers, neither will be counted as correct.

This answer sheet will be scored by an electrical test-scoring machine. This machine will score your paper accurately only if you use the special pencil that has been supplied, and if you indicate each answer with a solid black pencil mark. Solid black marks are made by going over each mark two or three times and by pressing firmly on the pencil. The test-scoring machine cannot distinguish between intended answers and stray pencil marks or dots. If you want to change any answer already marked, erase the mark completely and then mark the answered desired. Do not cross out a mark. If you are careless in erasing, or if you leave unintentional marks or dots on or near the answer spaces, such marks may be counted by the machine as wrong answers, and your score will be lower than it should be. Do not let your pencil touch any of the answer spaces until you actually mark your answer.

Make no marks on the test booklet. Scratch paper is supplied for you to use in making any drawings or computations you think necessary. Do not turn the next page until you are instructed to do so.

# RECEIVER

PLEASE NOTE: ALL ITEMS IN THE RECEIVER SECTION REFER TO THE SUPERHETERODYNE RECEIVER.




SUPERHET RECEIVER BLOCK DIAGRAM

1. A TERRIER receiver test with the Monitoring Panel indicates that the reference output voltage is Zero. The error output voltage is within limits (5.0 volts). Referring to the block diagram above, which one of the following blocks is most likely to be the source of this trouble?

   1. Reference blocking oscillator.
   2. Discriminator.
   3. Pulse stretcher and amplifiers.
   4. Decoder and cathode follower.

2. When testing the sensitivity of a TERRIER receiver with the Beam Simulator both error and reference signals vary erratically from zero to their normal values. Both voltages are Zero at the same time. Which one of the following stages is most likely to be defective?

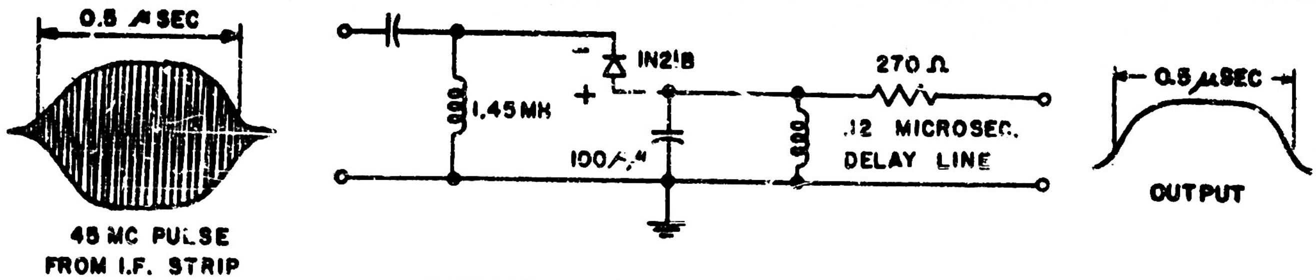
1. The I.F. strip.
2. The crystal mixer.
3. The local oscillator.
4. The AFC.

3. During a test of the TERRIER receiver it is found that there is no output from either the error or reference channels. In order to determine the cause, the following operations are performed; the results obtained are indicated.

| Operations Performed | Results Obtained |
| --- | --- |
| a. A coded and modulated 45 mc signal is fed into the I.F. strip input; error and reference channel outputs are observed. | a. Normal output on both channels. |
| b. "AFC on-off" switch placed in OFF position; klystron reflector voltage is varied; crystal mixer current is observed. | b. No crystal mixer current. |

Which of the following units is most likely to be defective?

1. An AFC phase comparator diode.
2. The klystron local oscillator.
3. The waveguide shutter.
4. The 400 cycle source.



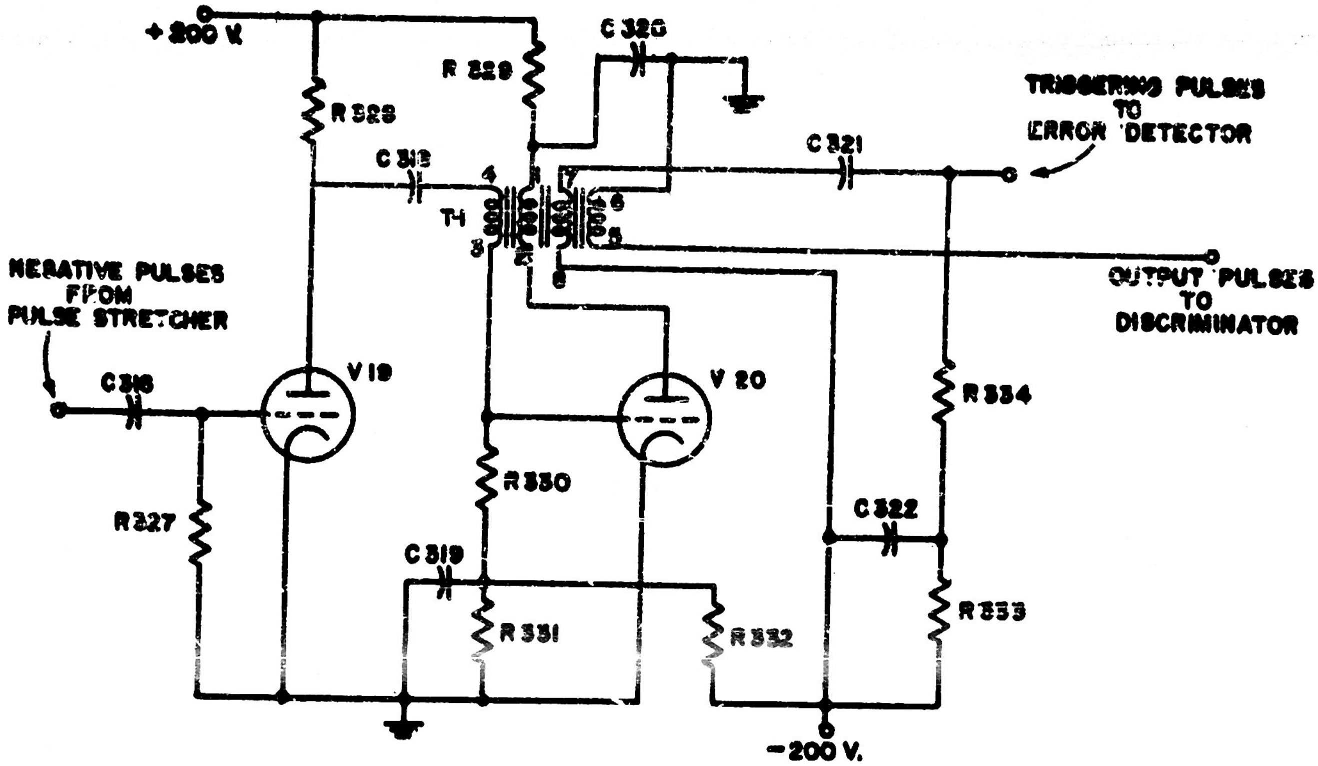

VIDEO DETECTOR

4. The waveshapes indicated above are observed on an oscilloscope. Which of the following components is defective?

1. The crystal.
2. The input inductance.
3. The delay line.
4. The 100 MMF condenser.

5. A TERRIER receiver unit is found to have a low error voltage output when given a missile systems test using the Monitoring Panel. A further check indicates a low pulse amplitude from the video detector. Tubes in both the I.F. and AFC units are checked and found to be good.
Which of the following is most likely to be defective?

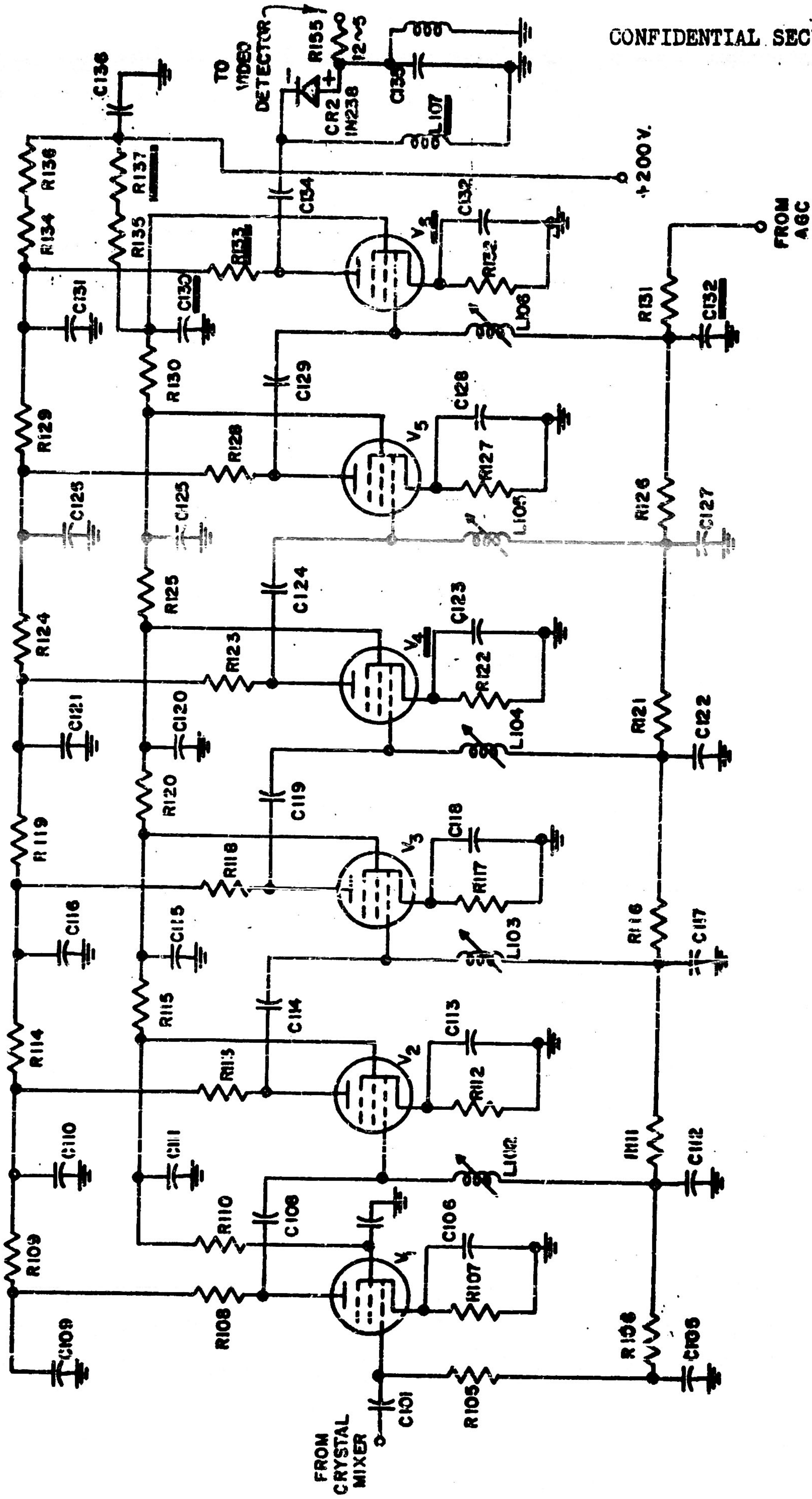
1. Waveguide mixer crystal.
2. Rotating waveguide section.
3. 45 mc. cable connectors.
4. Waveguide couplings.




BLOCKING OSCILLATOR

6. Trouble in a rejected TERRIER receiver is traced to the blocking oscillator. A voltage check on V-20 in the above diagram indicates that the plate voltage on this tube is much less than 200 V. Which of the following defects would <u>not</u> cause this symptom?

1. C-318 shorted.
2. C-319 shorted.
3. R-332 open.
4. R-331 open.



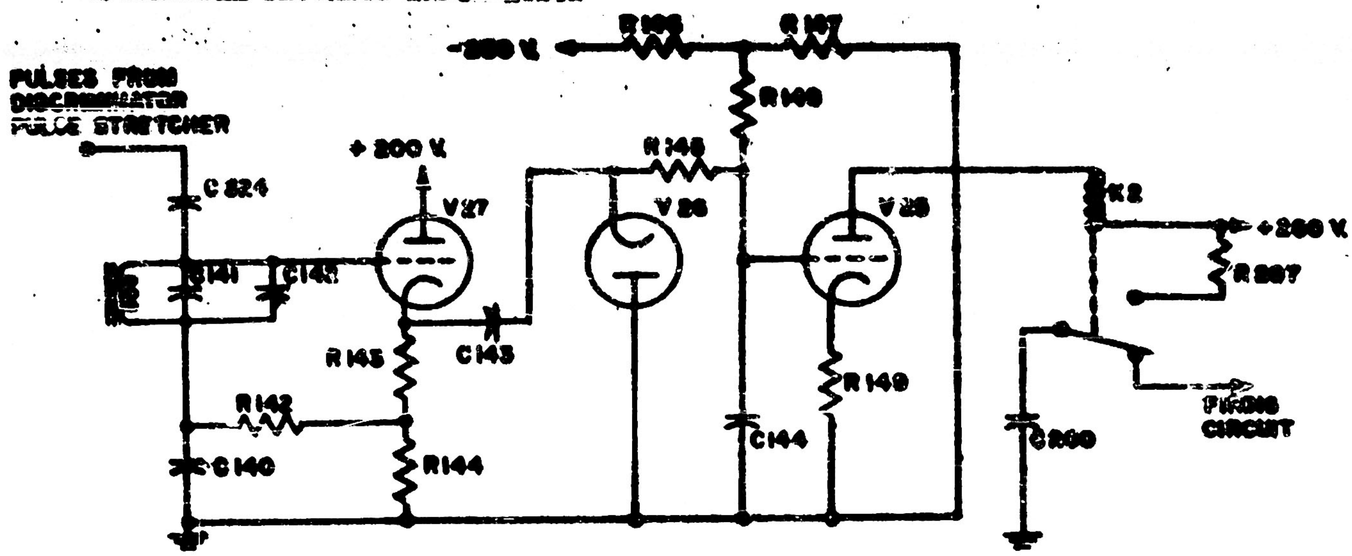

SCHEMATIC DIAGRAM I.F. STRIP

7. A TERRIER receiver is found to have 45 mc. oscillations in the I.F. section. Referring to the diagram on the opposite page, determine which of the following components would be most likely to cause this trouble if it were defective?

1. C-130 (screen decoupling capacitor on V-6) open.
2. C-132 (AGC decoupling capacitor) shorted.
3. R-137 (screen dropping resistor) shorted.
4. R-133 (plate resistor for V-6) open.

8. A TERRIER receiver when given a missile systems test using the Monitoring Panel gives a normal output on the reference channel but a high reading on the error channel. Which one of the following systems is most likely to be defective?

1. AGC.
2. Decoder
3. Discriminator.
4. Error pulse stretcher.




9. In a missile check with the FRI, the Destruct Circuit is found to be defective. A further check on the flight limiter circuit shown above indicates that relay K-2 energizes as soon as D.C. voltage is applied and before a 1350 cps signal is applied. Which of the following components, if defective, could cause this trouble?

1. C-140 open.
2. C-144 shorted.
3. R-146 shorted.
4. R-144 open.

# GUIDANCE SYSTEM

10. While checking the missile roll system sensitivity with the monitoring panel, it is noted that the rolleron angular positions are never great enough to be within tolerance. Which of the following <u>can be eliminated</u> as a cause of this difficulty?

1. Regulated power supply
2. Beam simulator
3. Gain change amplifier
4. Servo amplifiers

11. The "A" wings are found to make small slow movements about the zero position when no error signal is applied to the intelligence converter. No trouble is found with the "B" wing position. These wing movements are found to coincide with variations in the alternator output voltage. Which of the following is the most likely source of this trouble?

1. Poor emission variation compensation in the compensated D.C. amplifier.
2. Variation in the regulated D.C. voltages due to the A.C. variations.
3. Hydraulic pressure variations at the "A" wing control cylinder.
4. Movements of the servo amplifier feedback potentiometer due to pressure fluctuations in the hydraulic system.

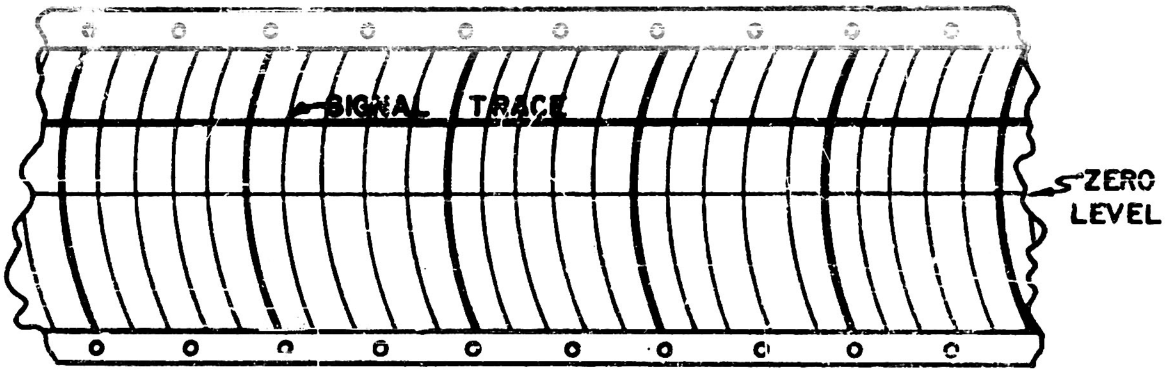
12. In a Monitoring Panel test, the results shown below are obtained.

| Conditions of Test | Signal from MP to Missile | Signal from Missile to MP | Tolerance Limits |
|---|---|---|---|
| Starting Conditions: Timer to 3 sec. | 30 cps reference and error signals to intelligence converter<br>Error: UP<br><br>Error: DOWN | Computer input monitor (adjusted to) A 6V B 6V<br>Wing position (measured) A 1.2° B 1.2°<br>Same as above with polarities reversed | 5.0° to 8.8°<br>5.0° to 8.8° |
| Starting Conditions: Timer to 10 sec. | As above<br>Error: UP<br><br>Error: DOWN | Computer input monitor (adjusted to) A 20V B 20V<br>Wing position (measured) A 4.0° B 4.0°<br>Same as above with polarities reversed | 2.6° to 5.1°<br>2.6° to 5.1° |

The encircled out of tolerance reading could be caused by a faulty:

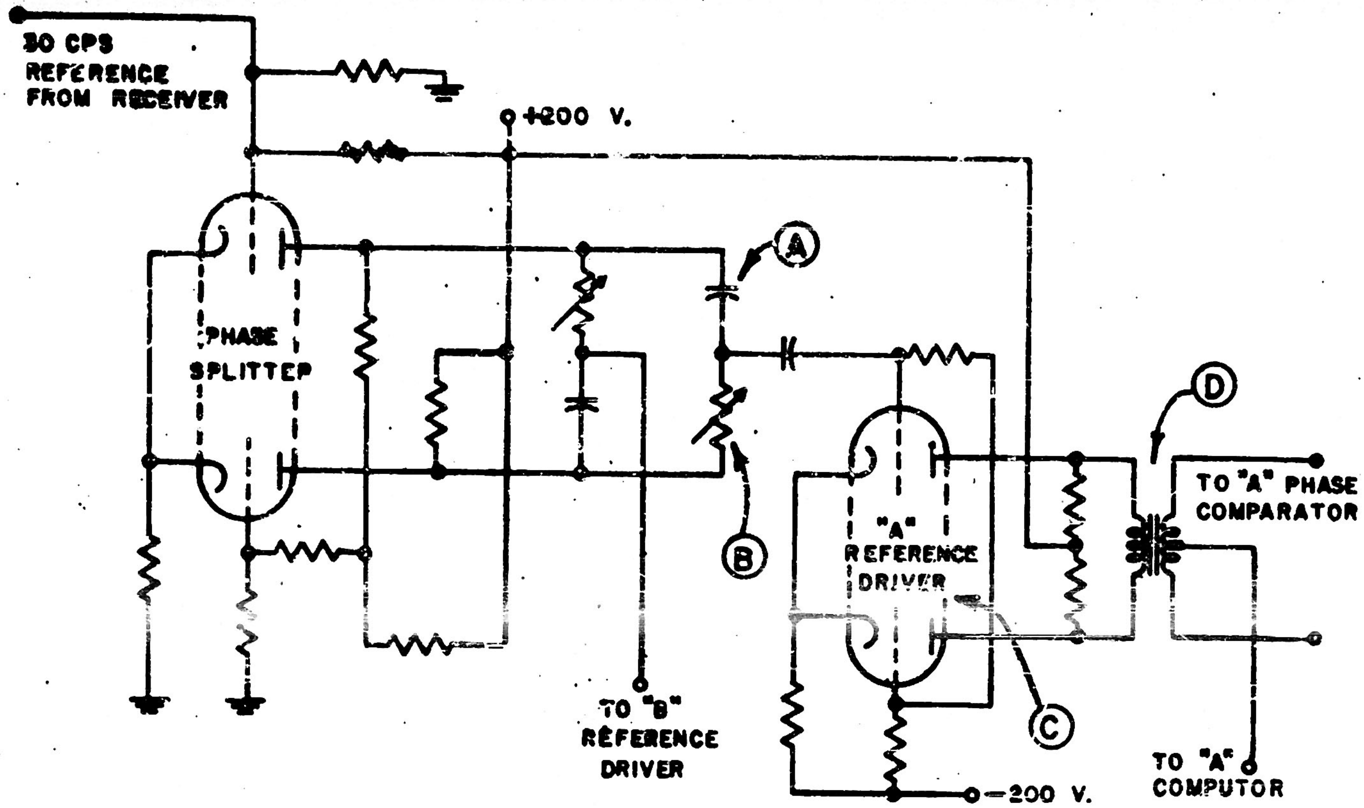
1. capture to guidance changeover switch.
2. ~~programmer motor.~~
3. floating limiter.
4. error signal driver.

13. A missile is being given a Roll Rate Change test using the Monitoring Panel. The Graham drive is set for a frequency of approximately 0.1 cps using the dial calibration. The Monitoring Panel No. 1 Brush recorder switch is at ROLL A.C. input. A deflection of 8 degrees, peak to peak, is obtained on the rolleron protractor. The test record obtained from the No. 1 Brush recorder is shown below.




The discrepancy between the protractor reading and the Brush recorder test record is due to:

1. The missile Roll Corrector's excitation failing.
2. The armature of the Gyro Pick Off synchro freezing to the stator.
3. The Brush recorder pen jamming.
4. The reference voltage supply of the Monitoring Panel demodulator failing.




14. In a test with the Monitoring Panel, the following results are obtained while attempting to adjust the missile phasing potentiometers.

| Signal to Missile from Monitoring Panel | Adjustment | Results Obtained |
|---|---|---|
| 30 cps reference and error signals: UP RIGHT AND DOWN LEFT | B wing phasing pot | B wing computer monitor volts can be adjusted to less than 1.3 V (the required maximum) with no effect on A wing computer monitor voltage. |
| 30 cps reference and error signals: UP LEFT AND DOWN RIGHT | A wing phasing pot | A wing can be adjusted to less than 1.3 V but the B wing computer monitoring voltage is found to decrease simultaneously, going to zero with A wing. |

Referring to the diagram above, determine which of the following is the faulty component?

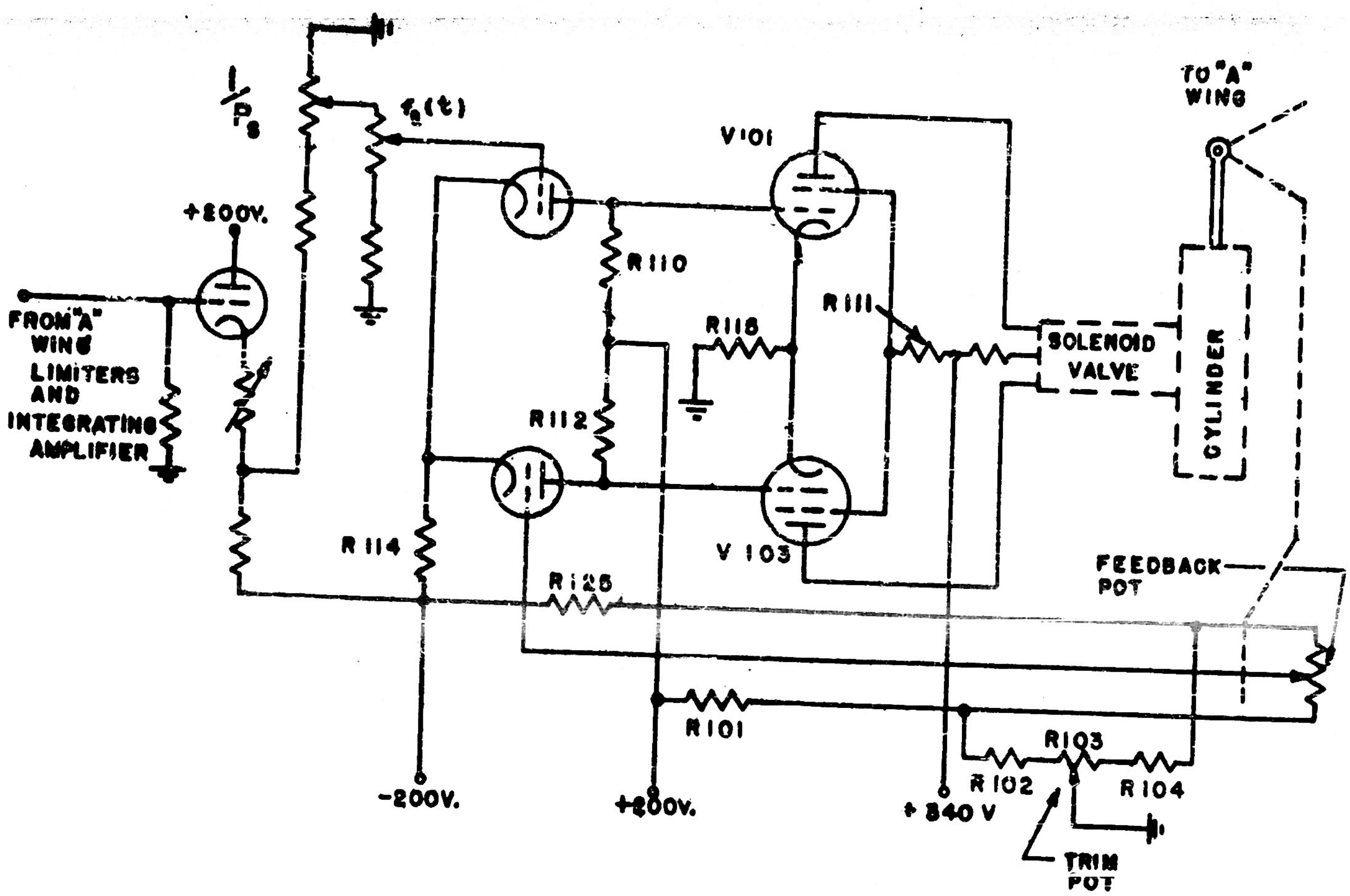
1. Condenser A, shorted.
2. Resistor B, open.
3. Tube C, open filament.
4. Transformer D, open primary.

15. In performing a missile systems test with the Monitoring Panel, the results shown below are obtained:

| Conditions of Test | Signal from Monitoring Panel to Missile | Signal from Missile to Monitoring Panel | Tolerance Limits |
|---|---|---|---|
| Starting Conditions; Timer 1 - 3 sec. | 30 cps Reference and Error signals to Intelligence converter<br>Error: UP | Computer input monitor (adjusted to) A 6 volts<br>B 6 volts<br>Wing position (measured) A 6.9°<br>B 7.2° | <br><br>5.0° to 8.8°<br>5.0° to 8.8° |
| | DOWN | Same as above with polarities reversed | |
| Timer to 10 sec. | As above<br>Error: UP | Computer input monitor (adjusted to) A 20 volts<br>B 20 volts<br>Wing position (measured) A 3.2°<br>B 4.0° | <br><br>2.6° to 5.1°<br>2.6° to 5.1° |
| | DOWN | Same as above with polarities reversed. | |
| Timer to 22 sec. | As above<br>Error: UP | Computer input monitor (adjusted to) A 20 volts<br>B 20 volts<br>Wing position (measured) A 4.9°<br>B 8.0° | <br><br>5.2° to 9.1°<br>5.2° to 9.1° |

The encircled out of tolerance reading could be caused by:

1. the "A" channel gain change network and programmer switch.
2. the programmer driving motor.
3. the "A" channel section of reference phase splitter.
4. the $F_1$ (t) potentiometer




SIMPLIFIED DIAGRAM OF "A" WING COMPUTER CATHODE FOLLOWER AND SERVO AMPLIFIER

16. During a dynamic guidance sensitivity check the input to the A wing servo amplifier is a low frequency sine wave. The recording of wing motion (voltage from wing position pot) shown in Fig. A below indicates that the wing is up against one of the stops.
Referring to the diagram at the top of this page determine which of the following could not cause the results obtained.

1. R-101, open.
2. R-111, open.
3. R-114, open.
4. Dirt in the hydraulic valve.

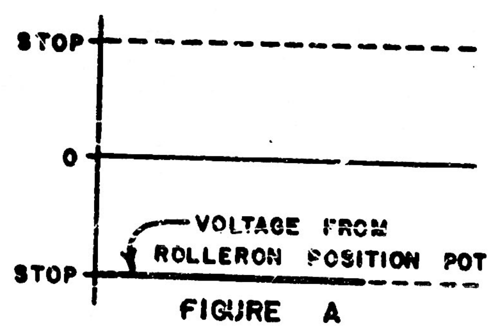
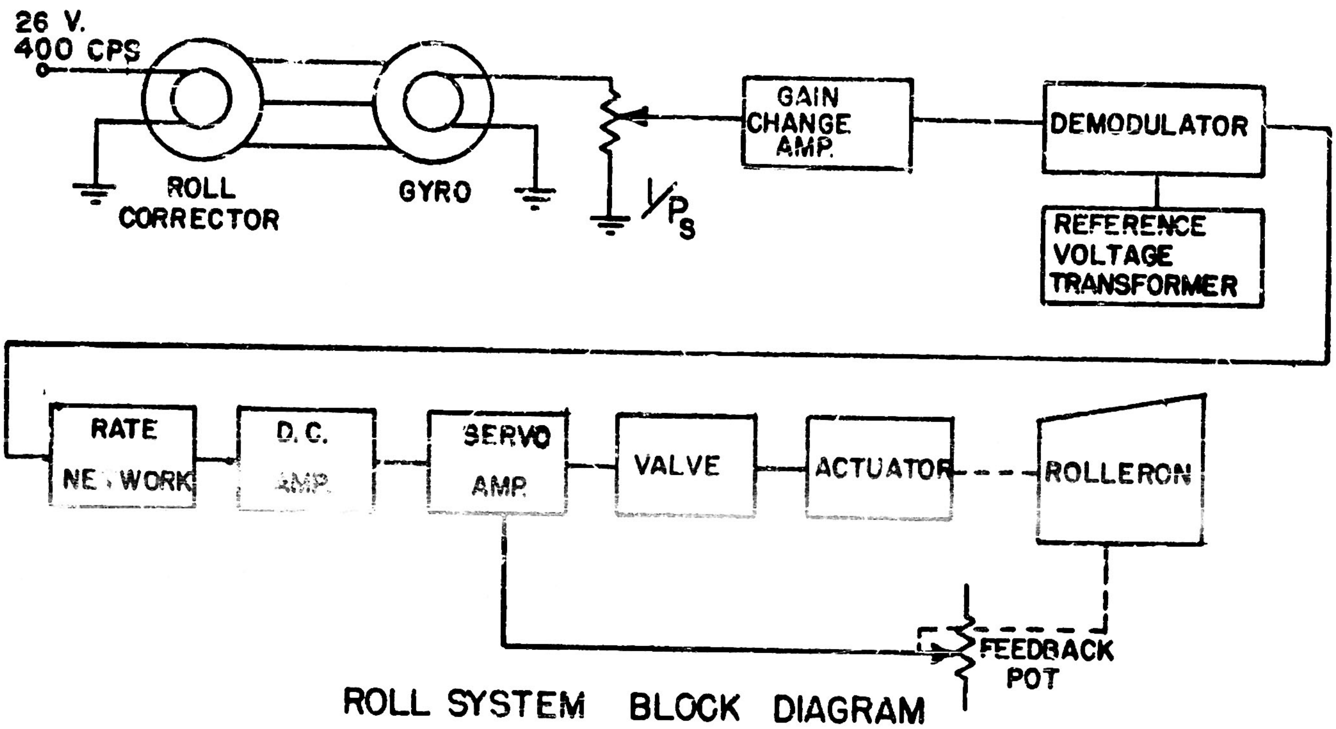



FIGURE A




ROLL SYSTEM BLOCK DIAGRAM

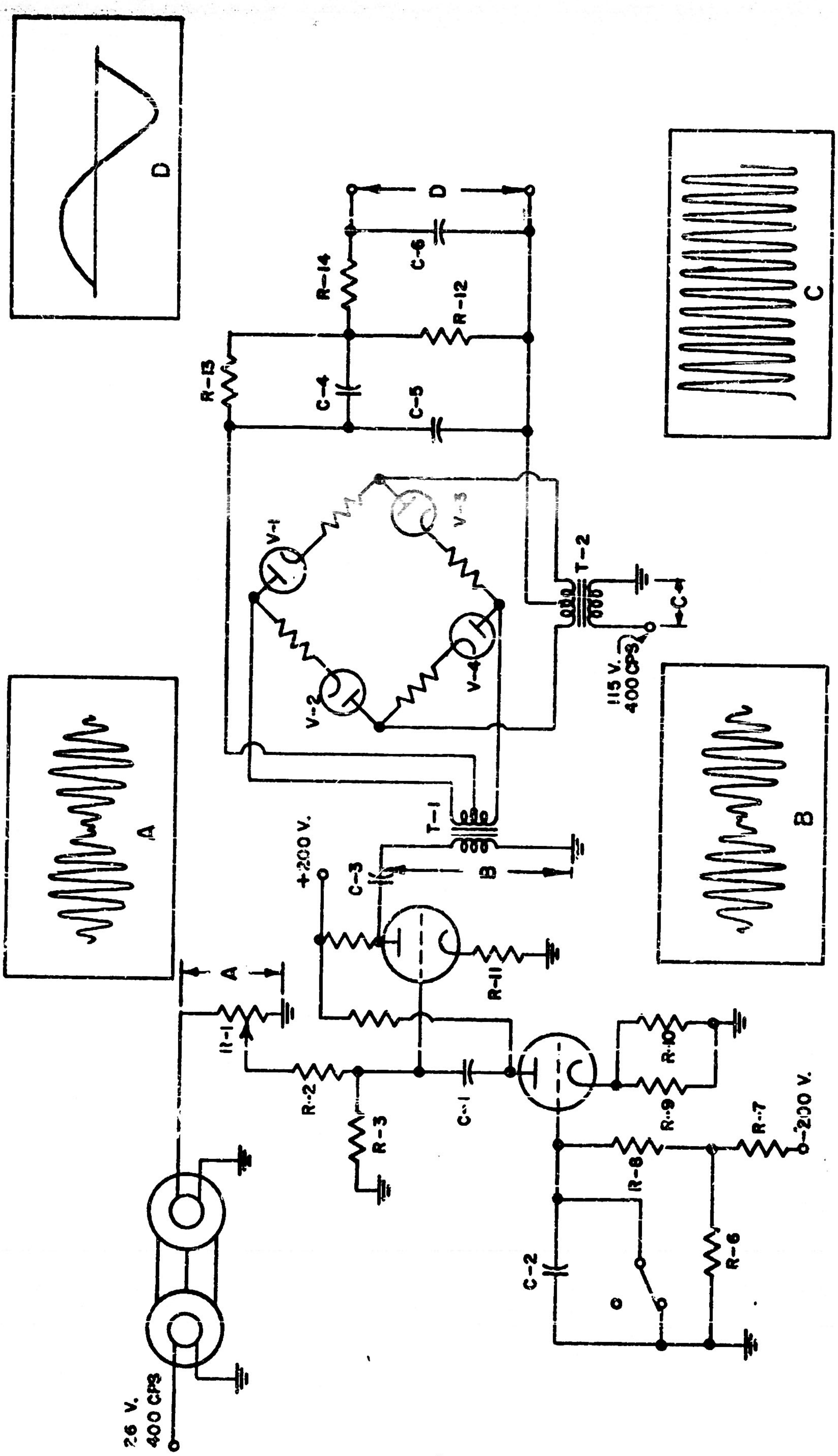
17. During a missile systems test, it is found that the overall gain of the Roll System is low. All other checks during the missile systems test are satisfactory.
In order to correct this condition it is necessary to:

1. replace the calibration resistor.
2. replace the Guidance Package.
3. make further checks to isolate the trouble.
4. replace both the Roll Corrector and Gyro Pick-off synchro.

| Roll Test Switch Position | Conditions of Test | Signal from Missile | Monitoring Panel Reading |
|---|---|---|---|
| "NORMAL" | Position missile $67\frac{1}{2}^{\circ}$ cw. Move Monitoring Panel roll corrector dial to $20^{\circ}$ ccw and back to $20^{\circ}$ cw. Wait 15 seconds and turn on missile operate switch. Roll missile to various roll attitudes. | Rolleron position on "position meter" and recorder #2. | All readings $0^{\circ}$ rolleron position |
| "SINE WAVE" | Low frequency sine wave to input roll servo amplifier (.1 cps, then 5.0 cps). | Same as above. Compute gain ratio from recorder records. | Normal gain ratio |
| "STEADY STATE" | 4.5 volt D.C. step signal to input servo amplifier. | Same as above. Compute maximum rolleron speed from recorder records. | Normal rolleron speed. |
| "RATE" | 400 cps signal, amplitude modulated with low frequency sine wave to demodulator. | Same as above. Check peak to peak rolleron angle. | All readings normal. |
| "CORRECTOR TEST" | Monitoring Panel roll corrector dial to various positions. | Rolleron position on "position meter" and recorder #2. | All readings normal. |

18. A partial record of a missile systems test using the Monitoring Panel and Roll Stand is reproduced above. The encircled Monitoring Panel reading indicates a missile malfunction.
Referring to the Block Diagram of the Roll System shown on the opposite page determine which one of the following needs to be replaced?

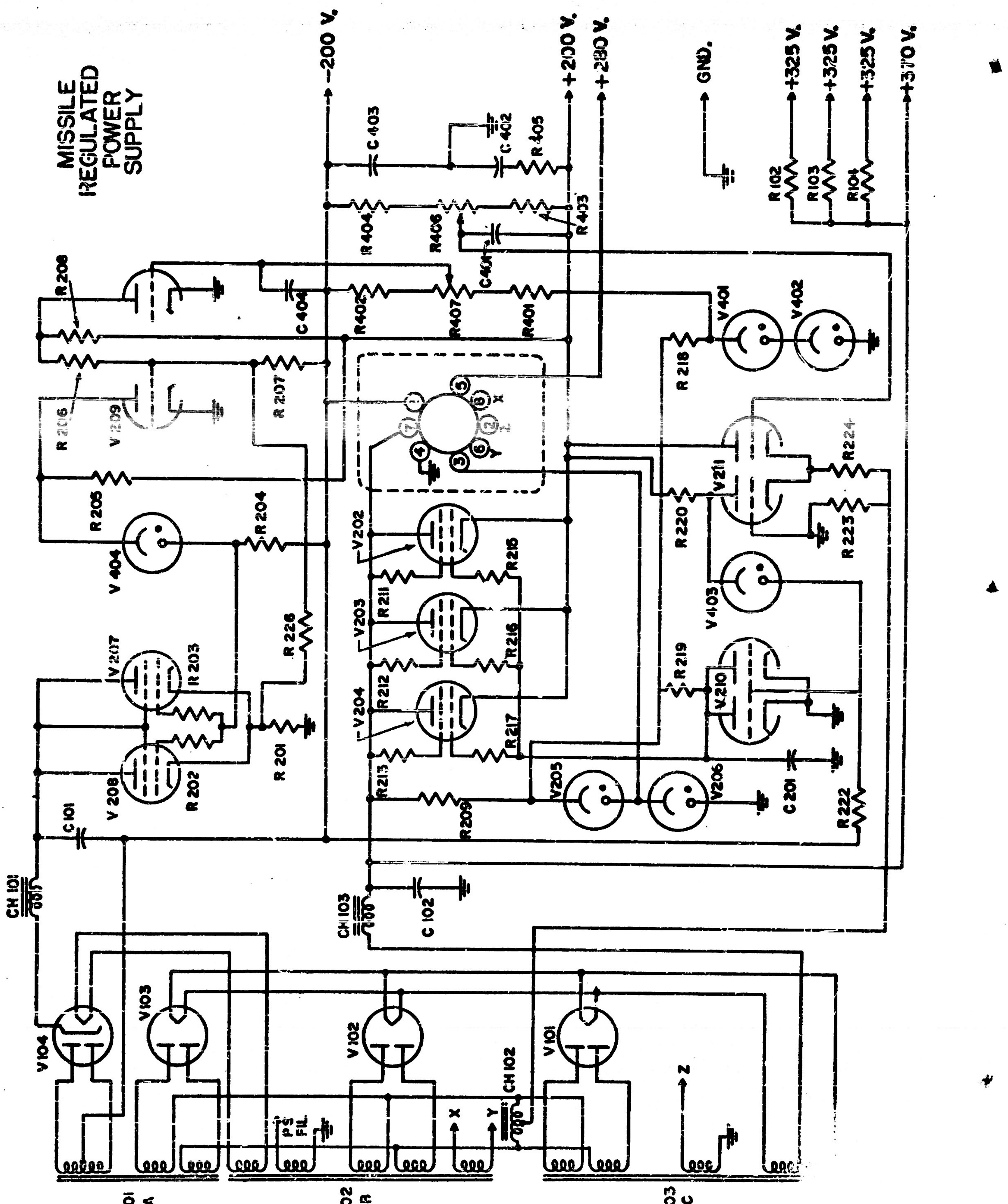
1. Roll Corrector Synchro
2. Guidance Package
3. Roll free gyro
4. Inverse pressure pot


D
C
A
B
R-13
R-14
C-6
R-12
C-4
C-5
V-1
V-2
V-3
V-4
T-2
115 V.
400 CPS
T-1
+200 V.
C-3
R-11
R-1
R-2
R-3
C-1
R-10
R-9
R-8
R-7
200 V.
C-2
R-6
26 V.
400 CPS

19. The schematic diagram of a portion of the roll system is shown on the opposite page along with the records of four signals seen on an oscilloscope during a missile systems test. Judging by the records the trouble is caused by:

1. Open secondary transformer T-1.
2. An open filament in one of the demodulator diodes.
3. Resistor R-12, open.
4. Capacitor C-1 shorted.

# ELECTRICAL SYSTEM
# (POWER SUPPLY AND SWITCHING)


MISSILE REGULATED POWER SUPPLY
-200 V.
+200 V.
+280 V.
GND.
+325 V.
+325 V.
+325 V.
+370 V.
T101 ØA
T102 ØB
T103 ØC

20. A diagram of the TERRIER regulated power supply is shown on the opposite page. During a missile systems test the -200 V supply output voltage is found to be zero. The input voltage to T-101 is normal. The voltage across C-101 is slightly higher than normal. The probable source of trouble is:

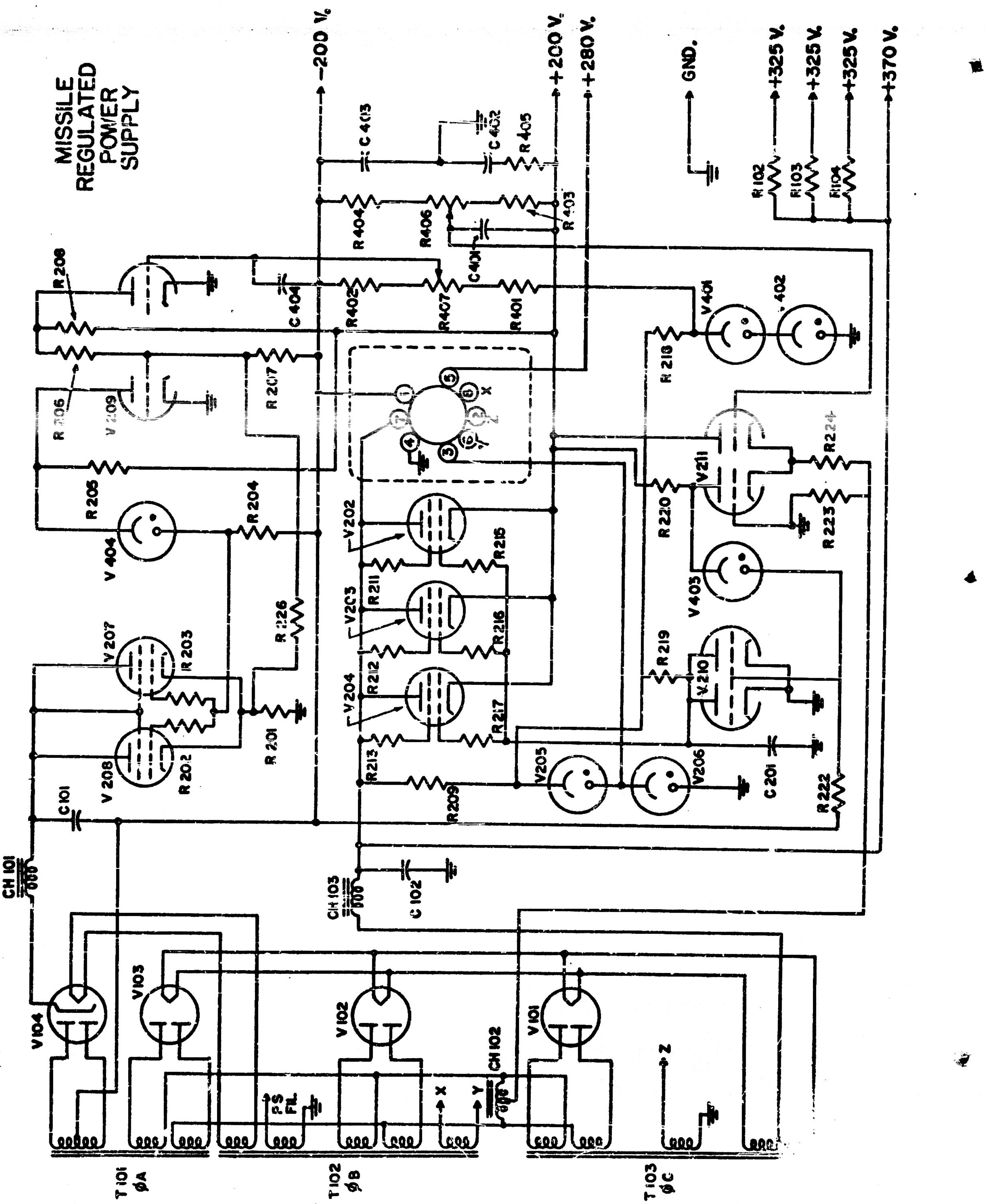
1. Resistor R-201 is shorted to ground.
2. Capacitor C-102 is shorted to ground.
3. Tube V-209 has failed.
4. Resistor R-201 is open.

21. The output of the +200 V regulated power supply shown on the opposite page is measured as +77 volts from the +200 V bus to ground. The regulator amplifier tubes are checked with a tube checker and found to be good. All regulator tubes are seen to glow.
Which of the following troubles is causing this difficulty?

1. Capacitor C-102 shorted.
2. Resistor R-209 open.
3. Resistor R-220 shorted.
4. Capacitor C-401 open.

22. While checking the regulated power supply shown on the opposite page, it is found that the +200 V supply voltage is almost +300 V. The voltage cannot be changed by adjusting R-406.
The component responsible for this condition is:

1. resistor R-403.
2. capacitor C-401.
3. tube V-211.
4. capacitor C-102.


MISSILE
REGULATED
POWER
SUPPLY
-200 V.
+200 V.
+280 V.
GND.
+325 V.
+325 V.
+325 V.
+370 V.
C 403
C 402
R 405
R 404
R 406
R 403
C 401
C 404
R 402
R 407
R 401
R 208
R 206
V 209
R 207
V 401
V 402
R 218
R 205
R 204
V 404
V 202
R 215
R 211
V 203
R 216
R 212
V 204
R 217
R 213
R 209
V 211
R 224
R 220
R 223
V 403
R 219
V 210
C 201
R 222
V 205
V 206
V 207
R 203
R 226
R 201
V 208
R 202
C 101
CH 101
CH 103
C 102
R 102
R 103
R 104
V 104
V 103
V 102
V 101
CH 102
X
Y
Z
FS
FIL
T 101
ϕA
T 102
ϕB
T 103
ϕC

23. It is found that the +200 V supply voltage is +325 V. Tubes V202, 203, 204, 210, 211 check good. (See diagram on opposite page.) Resistance checks between the pins of these tubes and ground show normal resistance. The setting of voltage adjusting potentiometer R-406 has no effect on the output voltage.
The trouble could be due to the failure of:

1. the -200 volt supply.
2. tube V-403.
3. resistor R-209.
4. capacitor C-401

24. The output voltage of the +200 V regulated power supply shown on the opposite page is being monitored on the Monitoring Panel oscilloscope as a part of a missile systems test. The oscilloscope pattern seen, with the scope sweep frequency set for 20K cps, is shown in Figure A below.
Which one of the following defects could cause this wave form?

1. Capacitor C-401 shorted.
2. Capacitor C-403 shorted.
3. Choke CH-103 shorted.
4. Resistor R-405 shorted.

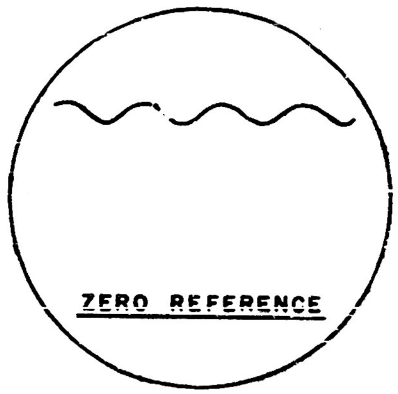
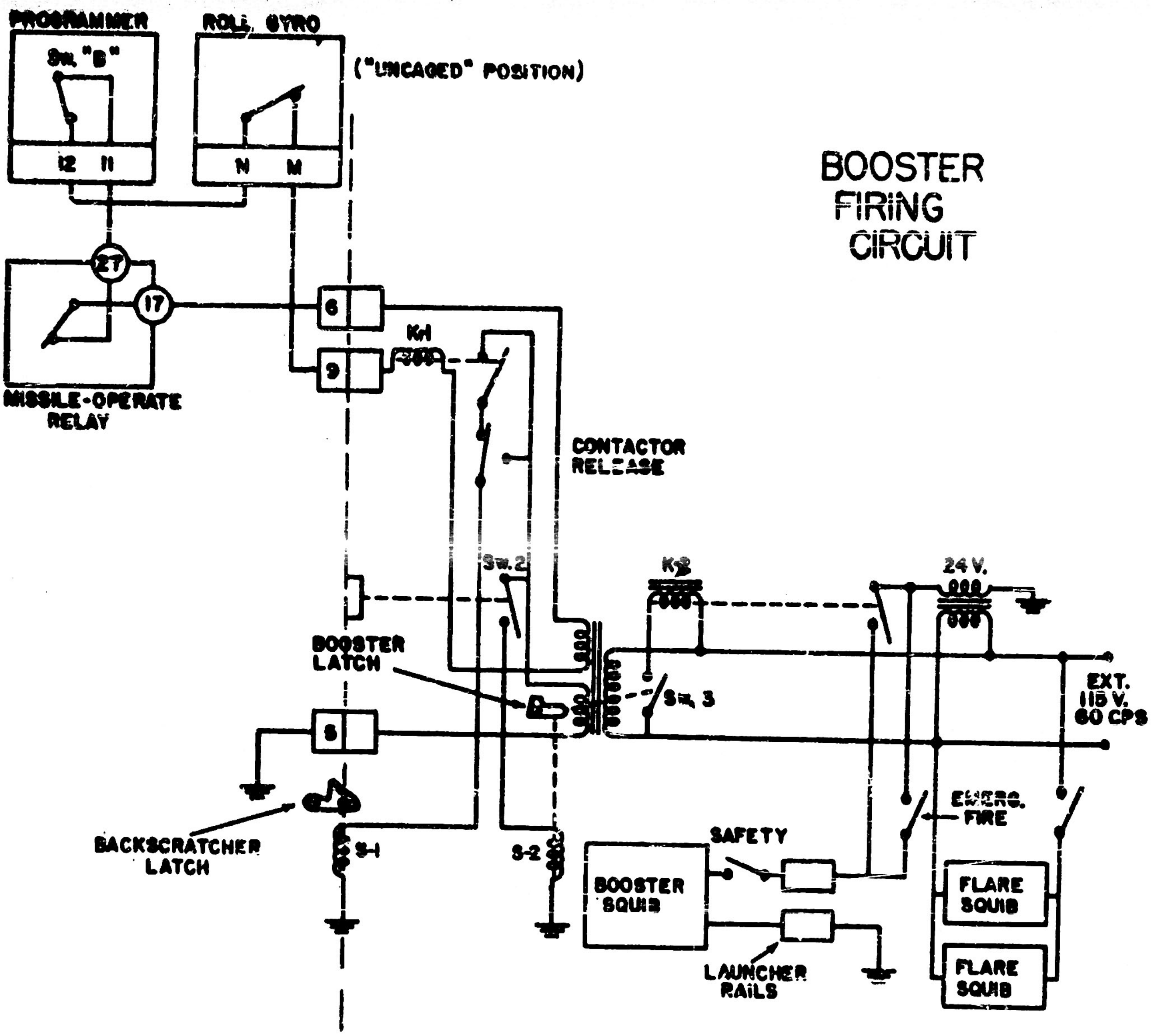



FIGURE A




25. The booster firing circuit is shown above. A defect causes the backscratcher to be ejected immediately as it is applied to the missile, even though the firing interlocks have not been closed. The reason for this trouble is:

1. a faulty backscratcher latch solenoid.
2. the Emergency Fire Switch is closed.
3. the contactor release over-ride switch is in the wrong position.
4. an open circuit in solenoid K-1.

26. A portion of a missile systems test check sheet is shown below.

| Test | Conditions of Test | M.P. Reading | Normal Range |
|---|---|---|---|
| Regulated Power Supply Check | External Power | -200.0 V<br>+200.2 V<br>Diff: 0.2 V | -200 ±2 V<br>+200 ±2 V<br>+0.2 V |
| Missile Operate Relay Check | Actuate Missile Operate Relay Switch | Gyro caged light: OFF | OFF |
| Firing Interlock Check | Turn on Programmer Run Switch (run to end of flight) | Firing Interlock OFF | ON |
| Gyro Cage | Deactivate Missile Operate Relay | Gyro caged light: ON | ON |
| Internal power & low voltage check | Turn on external air | Time for power changeover normal<br>Phase Lights normal<br>0 V. D.C.<br>410 cps<br>117 V | 0.8 sec.<br>Normal<br>25-3[illegible]V.D.C.<br>380 ±20 cps<br>105-121 V |

The component causing the trouble indicated by the check sheet is:

1. the high voltage power transformer.
2. the gyro caging motor.
3. the firing interlock circuit.
4. the low voltage rectifiers.

| Test | Conditions of Test | M.P. Reading | Normal Range |
|---|---|---|---|
| Regulated Power Supply Check | External power | -201.0 V<br>+200.9 V<br>Diff: 0.1 V | -200 ± 2 V<br>+200 ± 2 V<br>+0.2 V |
| Missile Operate Relay | Actuate Missile Operate Switch | Gyro caged light: OFF | OFF |
| Firing interlock Check | turn on programmer run switch (run to end of flight) | firing interlock light: OFF | OFF |
| | Deactuate missile operate relay | Gyro caged light: ON | ON |
| Internal Power and low voltage check | Turn on external air | No power change-over<br>Phase lights: NORMAL<br>30 V<br>110 V<br>393 cps | 0.8 sec.<br>Normal<br>25-35 V<br>105-121 V<br>380-420 cps |

Part of the results obtained in a missile systems test using the Monitoring Panel are shown on the opposite page. The out of tolerance reading is encircled.
Three components might have caused the trouble indicated.
Select one from each of the three lists below.

27.
1. The regulated power supply.
2. The alternator.
3. The backscratcher plug.
4. The 30 Volt D.C. power supply.

28.
1. The external 400 cps power.
2. The air shut-off valve solenoid.
3. The missile operate relay.
4. The firing interlock circuit.

29.
1. The power transformer.
2. The backscratcher latch solenoid.
3. The booster warmup contacts.
4. The power changeover relay.

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# PROFICIENCY EXAMINATION
# TERRIER MISSILE
## TROUBLE-SHOOTING : PART B
### EXPERIMENTAL FORM T-2

PREPARED UNDER THE SPONSORSHIP OF THE
BUREAU OF NAVAL PERSONNEL

OFFICE OF NAVAL RESEARCH
CONTRACT NUMBER N7onr-37008, NR-152-079

AMERICAN INSTITUTE FOR RESEARCH
PITTSBURGH, PENNSYLVANIA

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## GENERAL DIRECTIONS: TROUBLE SHOOTING, PART B

This is a test of your ability to locate a defective component when you are given a description of the faulty operation of a TERRIER missile, or of its associated test or servicing equipment.

Most of the questions in this test describe a faulty condition and ask you to identify the component which could cause this condition. Other questions describe a faulty condition or operation and ask you to identify one component which could not cause the condition. Read each question carefully.

Most of the test questions cannot be answered from memory. They require you to think carefully about the problem before you decide on the correct answer. In taking the test you will need to pay special attention to the diagrams which accompany the questions.

Be sure to answer every question in the test, but do not spend too much time on any one problem. Some of the questions are more difficult than others; if you are not completely sure of the correct answer to a problem, make the best guess you can and go on to the next one.

The examiner will instruct you how to fill out the enclosed answer sheet. When doing this print all information that is required. Mark your answers to the problems in this test on this answer sheet. For each question, heavily blacken the space which has the same number as the answer you select, as shown below:


In this example, Answer 3 is marked as being correct for problem I and Answer 4 is marked as being correct for problem II. Mark only one answer for each problem. If you mark two or more answers, neither will be counted as correct.

This answer sheet will be scored by an electrical test-scoring machine. This machine will score your paper accurately only if you use the special pencil that has been supplied, and if you indicate each answer with a solid black pencil mark. Solid black marks are made by going over each mark two or three times and by pressing firmly on the pencil. The test-scoring machine cannot distinguish between intended answers and stray pencil marks or dots. If you want to change any answer already marked, erase the mark completely and then mark the answer desired. Do not cross out a mark. If you are careless in erasing, or if you leave unintentional marks or dots on or near the answer spaces, such marks may be counted by the machine as wrong answers, and your score will be lower than it should be. Do not let your pencil touch any of the answer spaces until you actually mark your answer.

Make no marks on the test booklet. Scratch paper is supplied for you to use in making any drawings or computations you think necessary. Do not turn the next page until you are instructed to do so.

# AIR AND HYDRAULIC SYSTEM

1. During a missile system test using the Monitoring Panel, the power supply frequency generated in the missile is 500 cps rather than 400 cps. The hydraulic oil pressure fluctuation is within the allowed range of 1250 psi to 1600 psi. Which of the following components is most probably at fault?

   1. Air pressure regulator.
   2. Hydraulic motor flow regulator.
   3. Sump.
   4. Alternator.

During an attempted Flight Ready Indicator test on a missile, the autopac does not cycle. Inspection indicates that air does not escape from any exhaust port. Select one component or condition from each group below which might be the cause of this trouble.

2.
   1. Wing servo valves.
   2. Air shut off valve.
   3. Amount of oil in hydraulic system.
   4. Pressure relief disc.

3.
   1. Air pressure regulator.
   2. Rolleron actuator.
   3. Sump nitrogen pressure.
   4. Air storage bottle.

4.
   1. Hydraulic couplings
   2. Sump manifold poppet valve
   3. Hydraulic motor assembly
   4. Autopac valve slide assembly

5. A missile fails on a Flight Ready Indicator test because the power changeover relay does not actuate. Inspection of the missile reveals that although air flows through the autopac, the autopac piston does not oscillate.
Which of the following might cause this trouble?

1. A jammed oil outlet valve which causes the piston to stop in the middle of its stroke.
2. A jammed oil inlet valve which causes the piston to stop in the middle of its stroke.
3. A broken valve slide permitting both oil valves to remain open.
4. A broken valve slide permitting both air valves to remain open.

# GENERAL MISSILE SYSTEM

8. In checking the missile power supply with the Monitoring Panel, the output voltages of the regulated power supplies are within tolerance. However, the frequency of the A.C. supply is 50% greater than normal. This difficulty can be traced to the:

1. alternator
2. hydraulic motor flow regulator
3. rectifier transformers
4. voltage regulators

9. The Flight Ready Indicator checks some parameters of the missile directly and others indirectly by inference or circumstantial evidence, i.e., the operation of a system is checked under conditions other than the actual operating condition. Which one of the following systems is checked by inference?

1. Wing motion caused by saturation error signal.
2. Wing trim during boost phase
3. Rolleron position at roll zero attitude
4. Timer at 40 second position

# HYDRAULIC CHARGING UNIT

10. During an attempt to bleed a missile hydraulic system, the mercury levels of the Hydraulic Charging Unit vacuum gage can not be brought together. This can be caused by:

1. a fouled shut off valve.
2. a jammed hydraulic pump.
3. an improperly seated air valve.
4. jammed oil check valves.

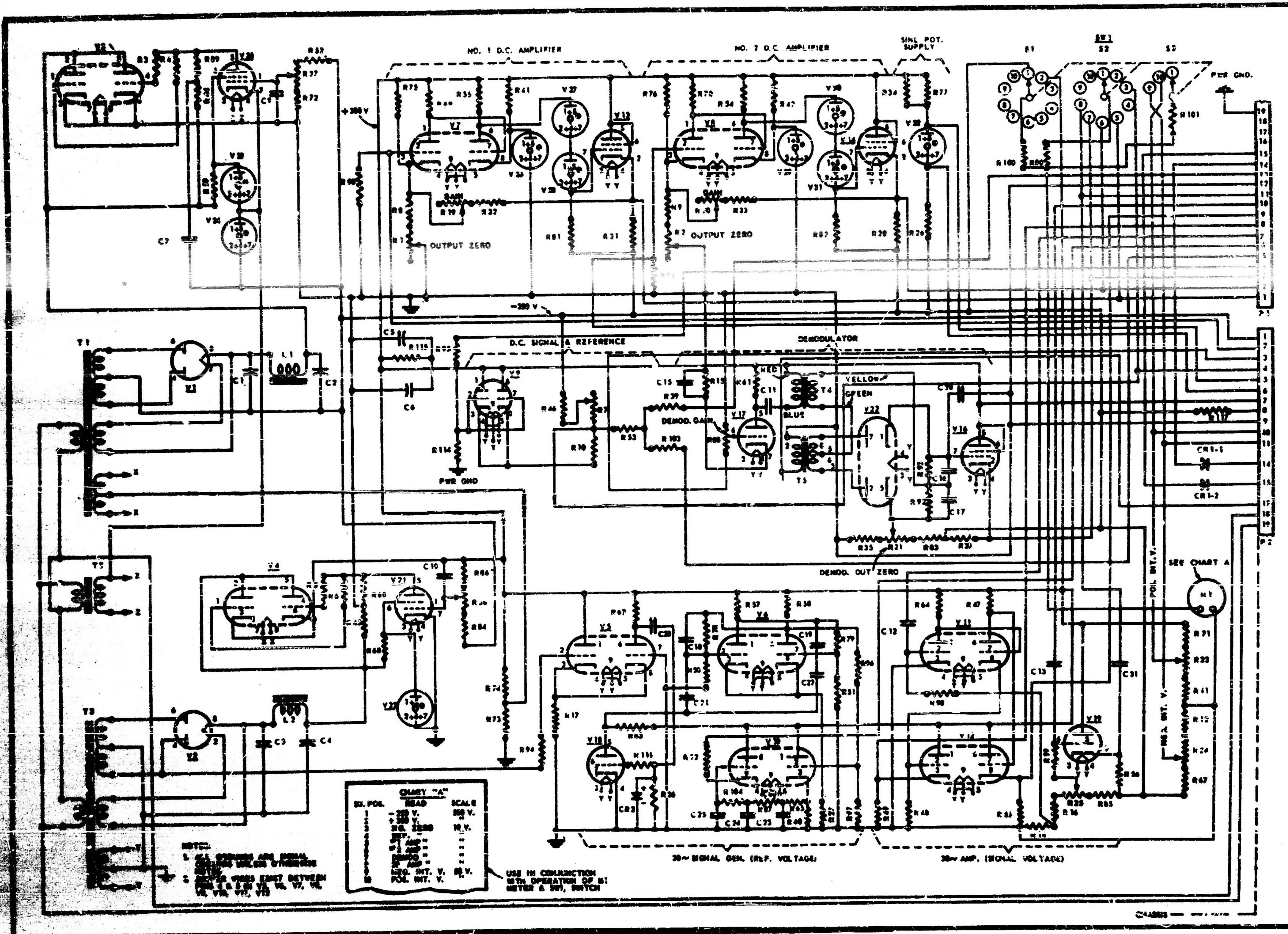
11. While operating the Hydraulic Charging Unit the vacuum manometer liquid levels can not be brought close together. Which of the following might cause this malfunction?

1. Drain plug open.
2. Vacuum break valve closed.
3. Vacuum intake valve closed.
4. Vacuum pump check valve jammed open.

12. When fluid in the Hydraulic Charging Unit is transferred from the sump to the reservoir it is observed that the liquid level in the hydraulic reservoir remains below the liquid level in the vacuum sump. Which of the following is not working properly?

1. The vacuum pump.
2. The hydraulic filter.
3. An oil check valve.
4. The filter bypass valve.

MONITORING PANEL

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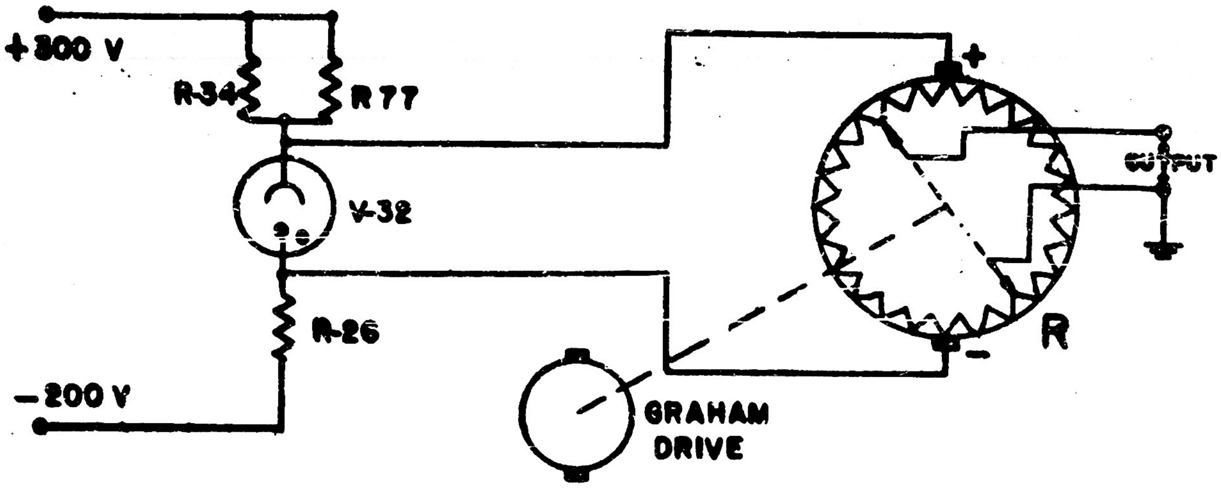
13. In checking the Monitoring Panel Electronic Chassis, (see diagram on opposite page) meter M-1 reads zero volts when switch SW-1 is in position 1, and +50 volts with SW-1 on position 2. The component which could cause this trouble is:

1. tube V-4.
2. tube V-1.
3. capacitor C-4.
4. capacitor C-9.




**MONITORING PANEL SINE WAVE POTENTIOMETER AND VOLTAGE SUPPLY**

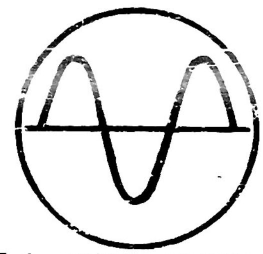


FIG. A NORMAL OUTPUT

14. The Monitoring Panel sine wave potentiometer and its voltage supply is shown in the schematic diagram above. If the normal sine output shown in Figure A is distorted so as to appear on the oscilloscope as shown in Figure B, the trouble can be traced to:

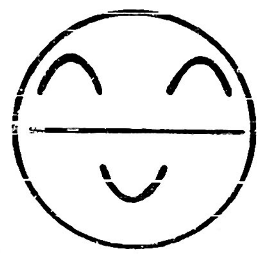
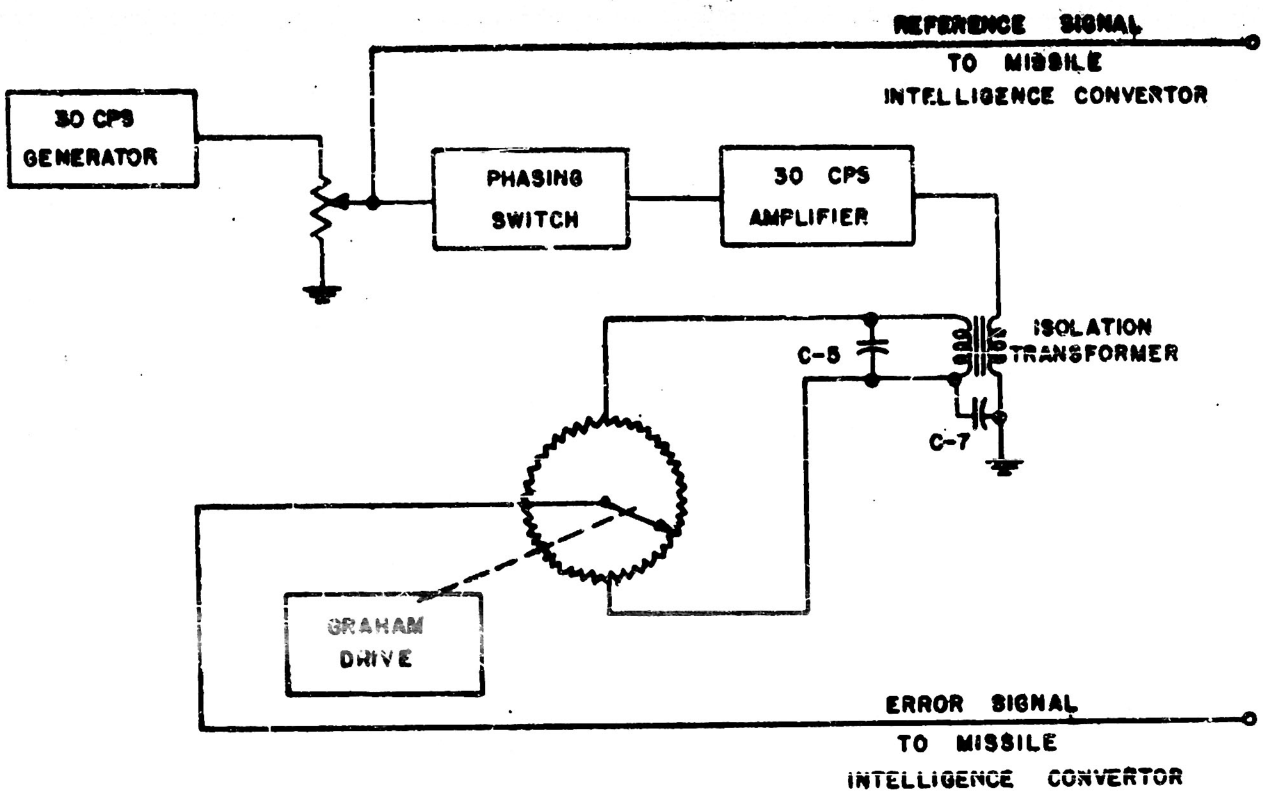


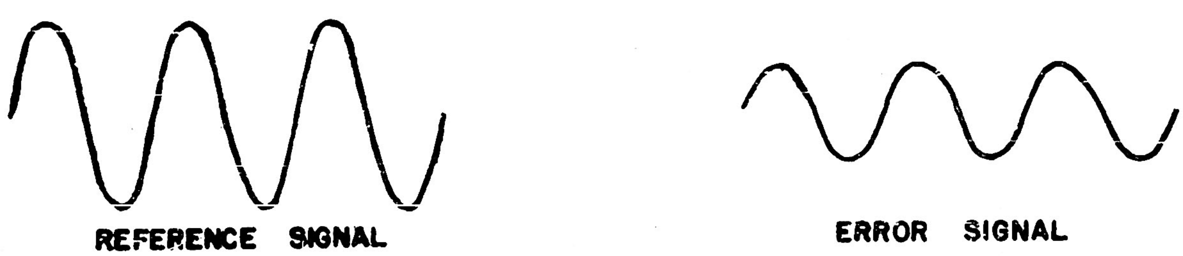
FIG. B ACTUAL OUTPUT

1. the voltage regulator tube (V-32).
2. the Graham drive.
3. the sine wave potentiometer (R).
4. resistor R-26.



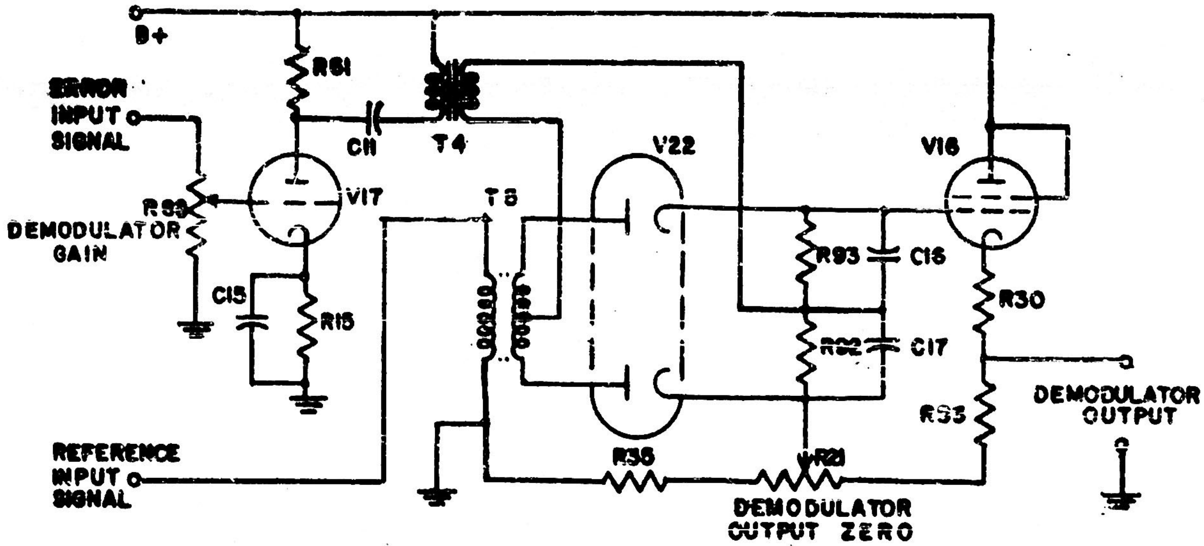

MONITORING PANEL SET UP USED FOR
DYNAMIC TEST OF WING CHANNELS

15. The reference and error signals from the Monitoring Panel set up shown above are monitored on the oscilloscope. The Graham drive is set at 5 cps and the scope sweep range switch on its lowest frequency position. The traces obtained are shown below.



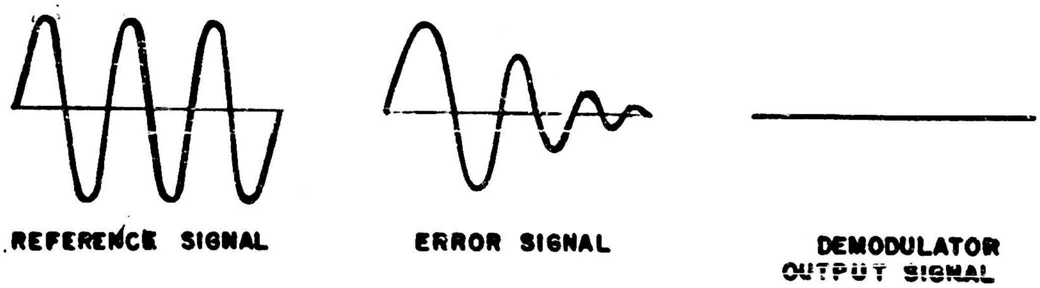

The faulty output can be traced to:

1. the sine wave potentiometer.
2. the coupling between the Graham drive and the sine wave potentiometer.
3. the 30 cps amplifier.
4. the isolation transformer and associated capacitors (C-5, C-7).




MONITORING PANEL DEMODULATOR

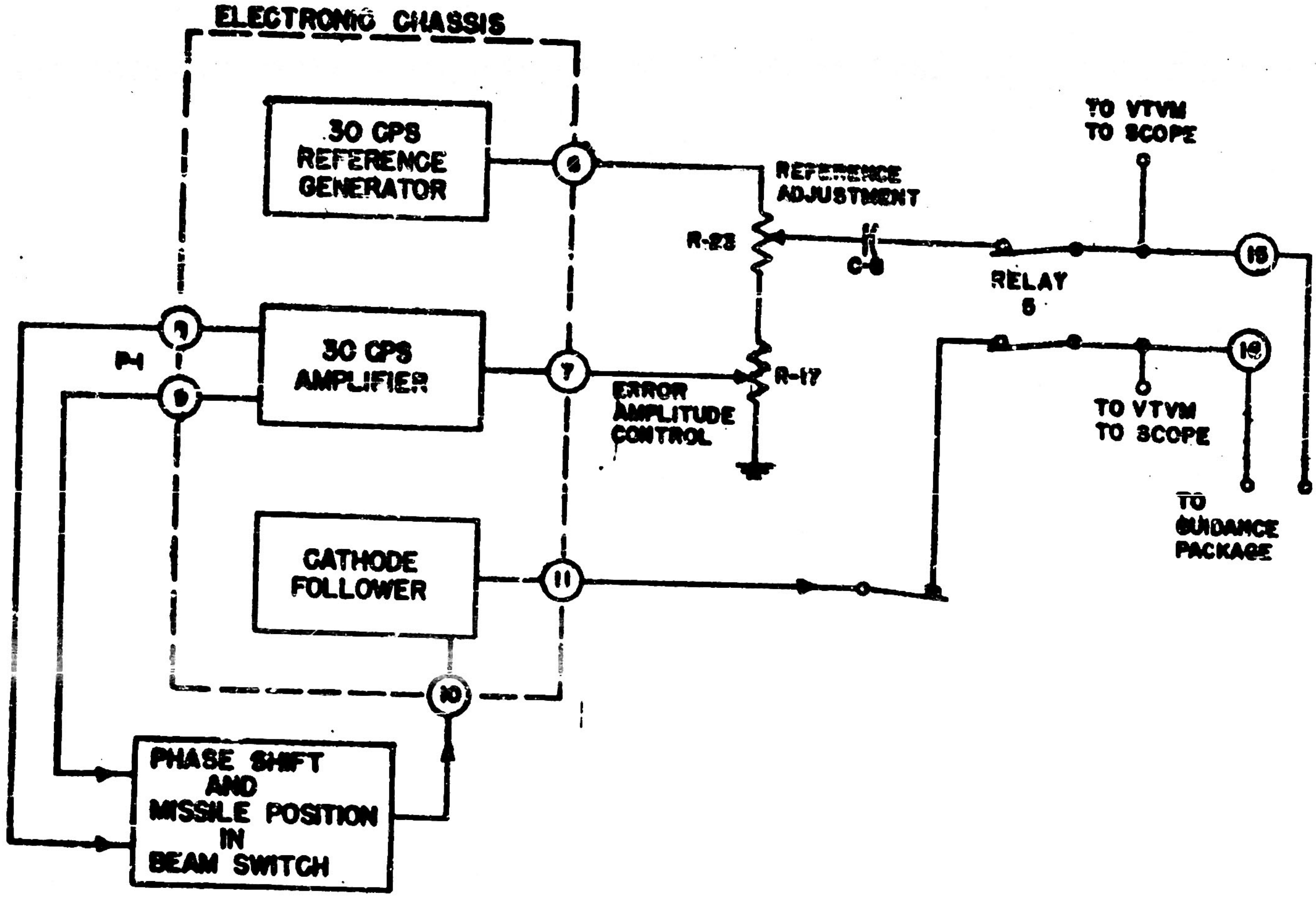
A schematic diagram of the Monitoring Panel demodulator is shown above. The input and output signals as seen on an oscilloscope are shown below. Select from each of the three groups of components below, one component which could not cause the faulty output signal.




16.
1. R-88
2. R-61
3. V-17
4. C-15

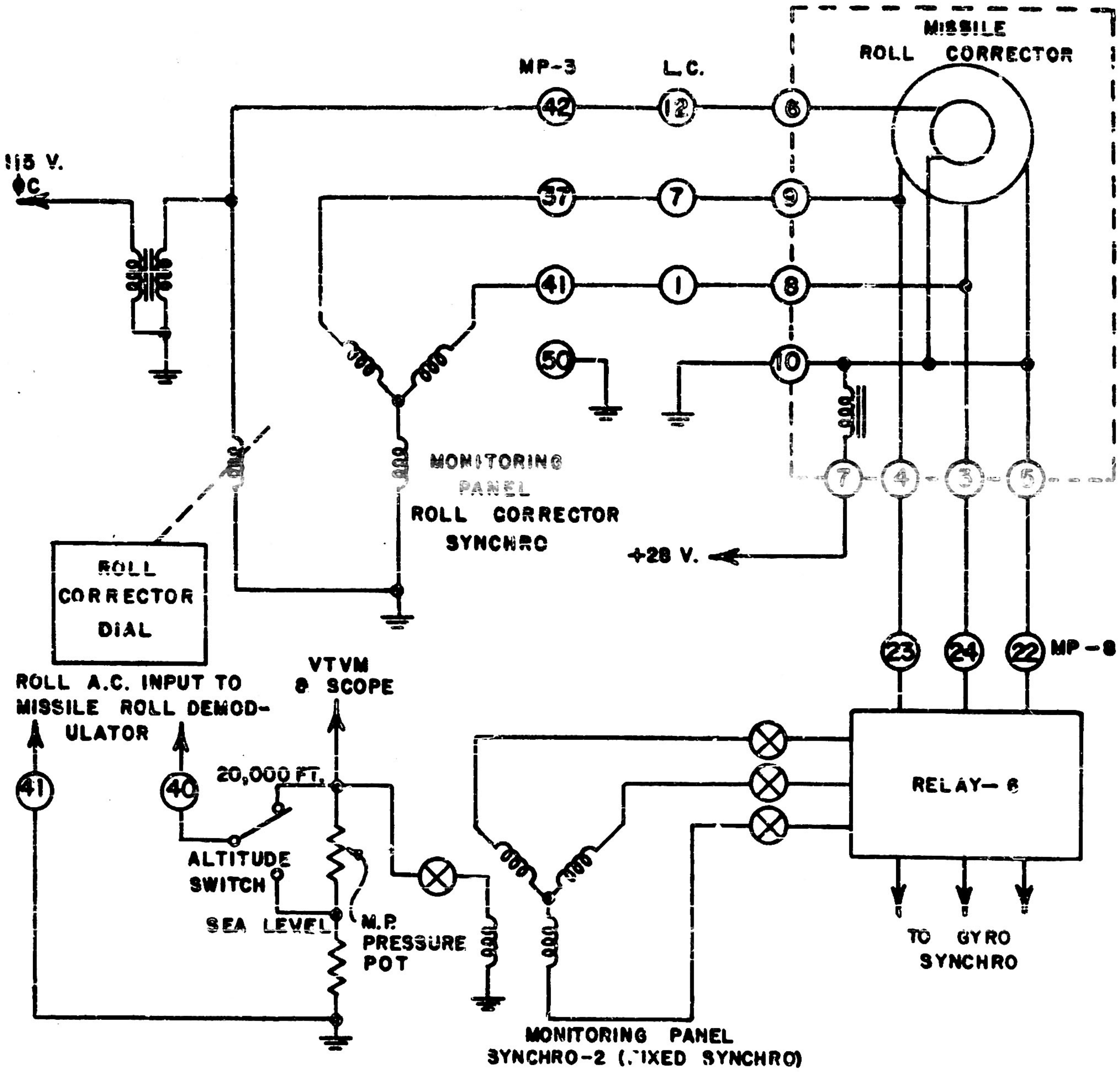
17.
1. T-5
2. V-16
3. T-4
4. R-93

18.
1. C-17
2. R-83
3. R-30
4. R-35




19. The Monitoring Panel set up for the steady state test of the 30 cps intelligence converter is given above. The error signal seen on the Monitoring Panel oscilloscope is normal, but the reference signal is missing. This trouble is due to:

1. Capacitor C-8 open.
2. No output from 30 cps reference generator.
3. Potentiometer R-17 shorted.
4. Open coil on relay 5.




SCHEMATIC DIAGRAM
MONITORING PANEL SET UP FOR ROLL
CORRECTOR TEST

20. The Monitoring Panel set-up used for a Roll Corrector test is shown on the opposite page. It is discovered that the phase of the Roll A.C. input is incorrect for Roll Corrector tests.

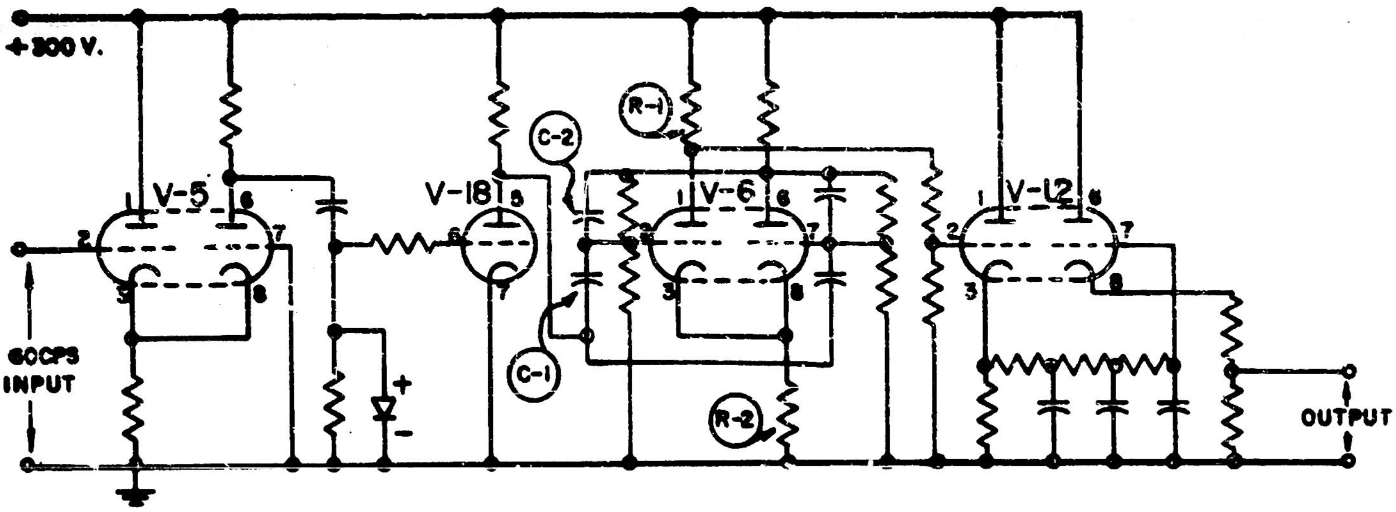
As a check the following is done:

a. Pins 37, 41, and 50 of Plug 3 are patched to pins 23, 24, and 22 of Plug 8 respectively. The dial on the Monitoring Panel roll corrector synchro is set on zero. With the Roll Corrector switch set to CORRECTOR TEST, the Roll A.C. input is measured as zero volts (normal).

b. With the Altitude Switch at 20,000 feet, the A.C. voltage between pin 40 of Plug 8 and pin 42 of Plug 3 is measured as zero volts (normal reading 40 volts).

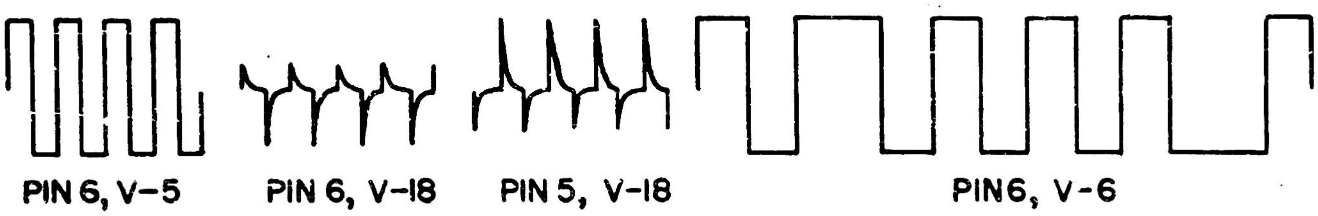
The next step should be to:

1. connect the transformer exciting the Monitoring Panel roll corrector synchro to phase A of the 400 cps power supply.
2. reverse any two of the connections between the roll corrector synchro and Monitoring Panel Plug 3.
3. rotate the armature of the Monitoring Panel Fixed Synchro 180° from its present position.
4. reverse the connections to terminals 40 and 41, Monitoring Panel Plug 8.




MONITORING PANEL 30 CPS REFERENCE SIGNAL GENERATOR

21. The Monitoring Panel 30 cps Reference Signal Generator is shown above. An oscilloscope connected to various points in the circuit shows the following waveforms:



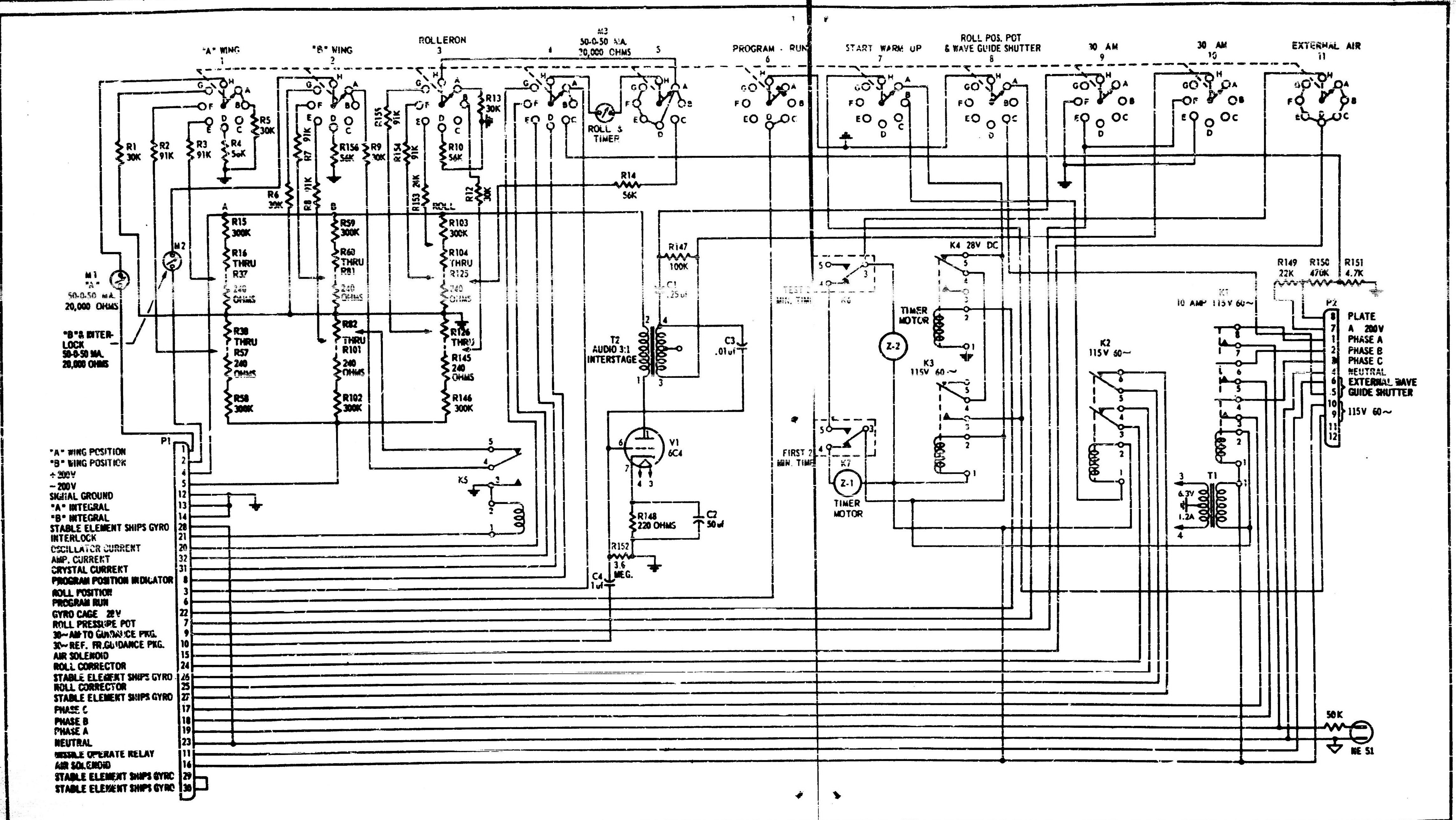

All vacuum tubes are checked and found to be good. Which of the following are responsible for the erratic output from V-6?

1. R-1 (high resistance).
2. R-2 (open).
3. C-1 (open).
4. C-2 (open).

OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |
| FLIGHT READY INDICATOR | | | |




*Wiring Diagram of Flight-ready indicator*

22. During a missile test with the Flight Ready Indicator, a meter reading in the red region indicates a malfunction in the self destruct circuit. A systems test with the Monitoring Panel, however, reveals that all missile circuits are functioning properly. Assuming that the fault is in the Flight Ready Indicator, which of the following should be checked first? (See diagram on preceding page.)

1. F.R.I. amplifier
2. F.R.I. roll voltage divider (R103 to R146)
3. Contacts in F.R.I. plug $P_1$
4. Contacts in F.R.I. plug $P_2$

23. A missile checkout with the Flight Ready Indicator indicates malfunctioning of both A and B wing floating limits for both positive and negative error signal polarity. Further testing of the missile with the Monitoring Panel establishes that all missile circuits are functioning properly. Assuming that the fault is in the Flight Ready Indicator, which of the following should be checked first? (See diagram on preceding page.)

1. F.R.I. amplifier
2. Contacts in F.R.I. plug $P_2$
3. B channel voltage divider
4. Wafers 3, 4, and 5 on the rotary switch

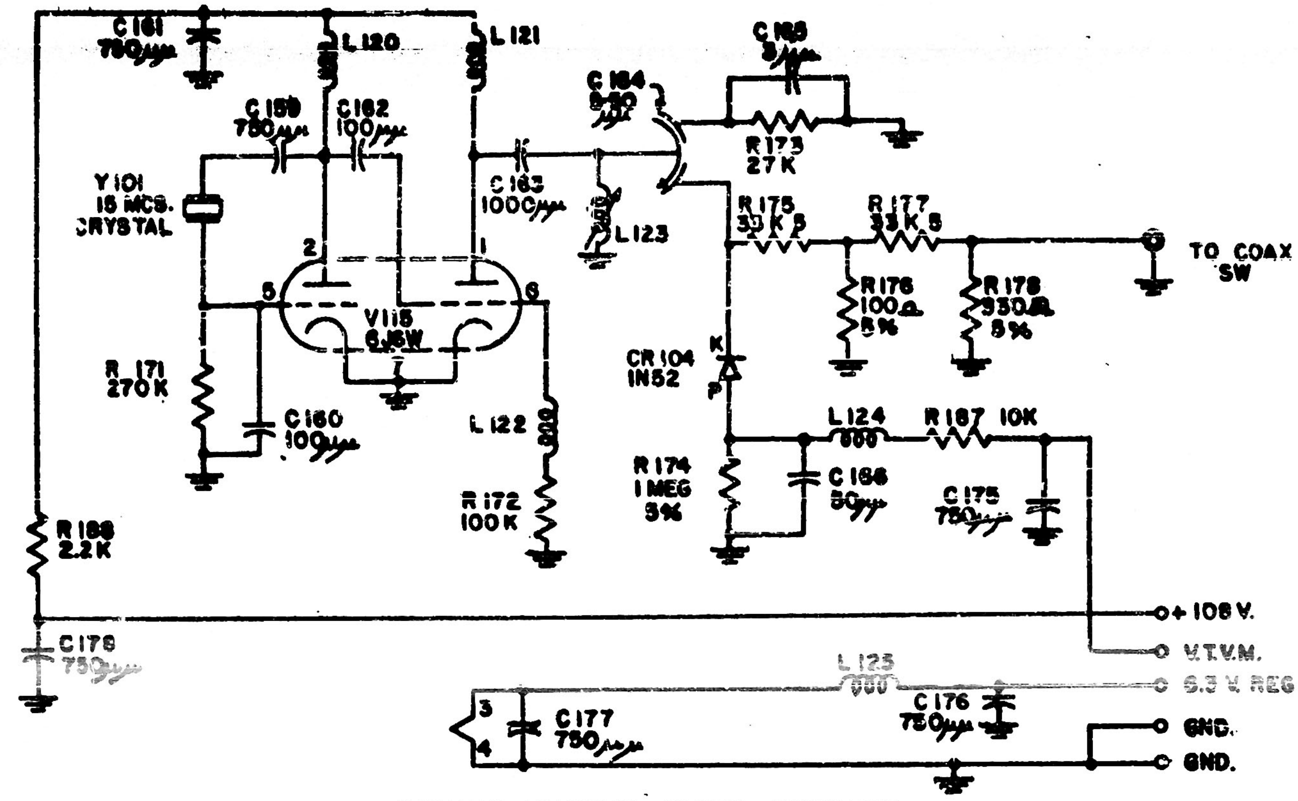
24. The circuit diagram shown on page 22 is a schematic of the Flight Ready Indicator with the main switch on position A. The external air solenoid valve does not operate after the two minute warm-up time. Using the diagram, which one of the following is least likely to cause the solenoid to be inoperative?

1. Failure of the main switch to make contact on Wafer 11, position A.
2. Failure of the main switch to make contact on Wafer 7, position A.
3. Failure of the timer switch K-7 to make connection between contacts 3 and 5 at the end of the two minute warm-up period.
4. Failure of the timer switch K-6 to make connection between contacts 3 and 5.

25. The following results were reported on a Flight Ready Indicator check: All three meters indicated within tolerance readings on switch position A; when the switch was moved from position A to B, the missile shut down. Using the schematic of the Flight Ready Indicator shown on page 22 determine which of the following missile components is most likely to be defective?

1. The gyro uncage unit.
2. The alternator.
3. The hydraulic system.
4. The firing interlock.

GUIDANCE ANALYZER




GUIDANCE ANALYZER 45 MCS. GENERATOR

26. The schematic of the Guidance Analyzer 45 mc. generator is given above. The output voltage, as indicated by the VTVM is one volt. The normal output voltage is three to four volts. Assuming that the trouble is in the 45 mc. generator which of the following should be suspected?

1. An open r.f. choke L-120.
2. A cracked crystal ~~V-101.~~ Y-101
3. An open filament V-115.
4. A faulty crystal CR-104.

27. A Guidance Analyzer has just been calibrated. However, when checking the PRF of the Beam Simulator, the PRF meter in the Guidance Analyzer does not deflect. Assuming that the trouble is in the Guidance Analyzer, which one of the following stages should be checked first?

1. PRF generator.
2. Decoder.
3. Discriminator.
4. AGC Detector.

28. No spot can be obtained on any control knob position for the synchroscope in the Guidance Analyzer. The signal from the intensity gate is found to be satisfactory. The output of which of the following should be checked next?

1. Low voltage power supply.
2. High voltage power supply.
3. Marker generator.
4. Sweep follower and inverter.

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# PROFICIENCY EXAMINATION
# TERRIER MISSILE
## KNOWLEDGE OF OPERATION : PART A
### EXPERIMENTAL FORM K-2

PREPARED UNDER THE SPONSORSHIP OF THE
BUREAU OF NAVAL PERSONNEL

OFFICE OF NAVAL RESEARCH
CONTRACT NUMBER N7onr-37008, NR-152-079

AMERICAN INSTITUTE FOR RESEARCH
PITTSBURGH, PENNSYLVANIA

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## GENERAL DIRECTIONS: KNOWLEDGE OF OPERATIONS, PART A

This is a test of your knowledge of the principles underlying the operation of the TERRIER missile and its associated test and servicing equipment.

Most of the questions in this test cannot be answered quickly from memory. They require you to think carefully about the problem before you decide on the correct answer. In taking the test you will need to pay special attention to the diagrams which accompany the questions.

Be sure to answer every question in the test, but do not spend too much time on any one problem. Some of the questions are more difficult than others; if you are not completely sure of the correct answer to a problem, make the best guess you can and go on to the next one.

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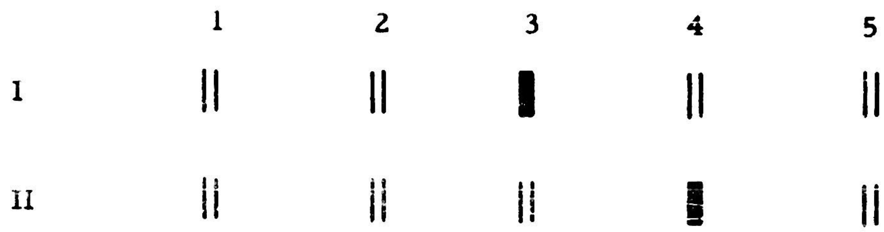


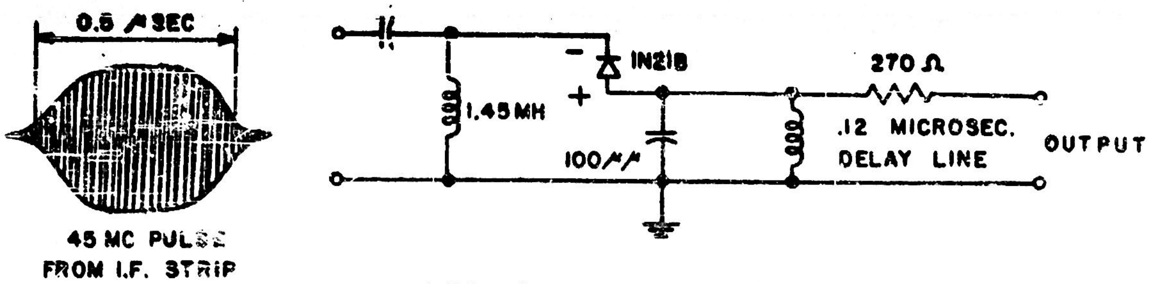

In this example, Answer 3 is marked as being correct for problem I and Answer 4 is marked as being correct for problem II. Mark only one answer for each problem. If you mark two or more answers, neither will be counted as correct.

This answer sheet will be scored by an electrical test-scoring machine. This machine will score your paper accurately only if you use the special pencil that has been supplied, and if you indicate each answer with a solid black pencil mark. Solid black marks are made by going over each mark two or three times and by pressing firmly on the pencil. The test-scoring machine cannot distinguish between intended answers and stray pencil marks or dots. If you want to change any answer already marked, erase the mark completely and then mark the answer desired. Do not cross out a mark. If you are careless in erasing, or if you leave unintentional marks or dots on or near the answer spaces, such marks may be counted by the machine as wrong answers, and your score will be lower than it should be. Do not let your pencil touch any of the answer spaces until you actually mark your answer.

Make no marks on the test booklet. Scratch paper is supplied for you to use in making any drawings or computations you think necessary. Do not turn the next page until you are instructed to do so.

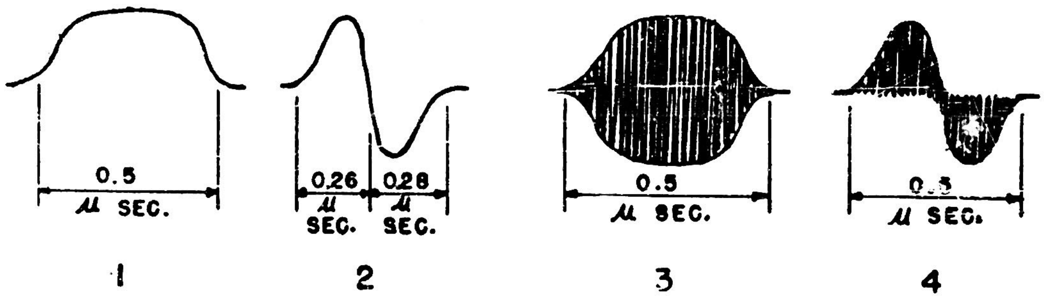
# RECEIVER

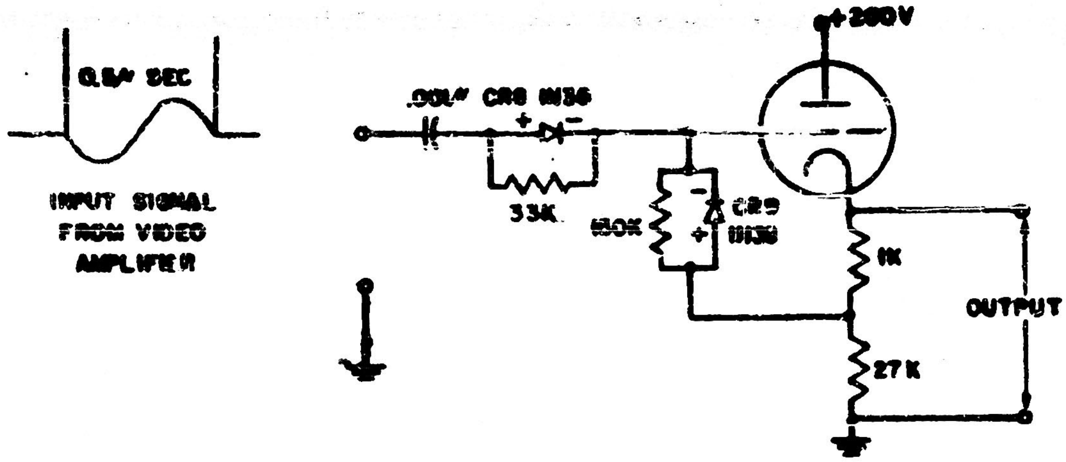
PLEASE NOTE: ALL ITEMS IN THE RECEIVER SECTION REFER TO THE SUPERHETERODYNE RECEIVER.




VIDEO DETECTOR

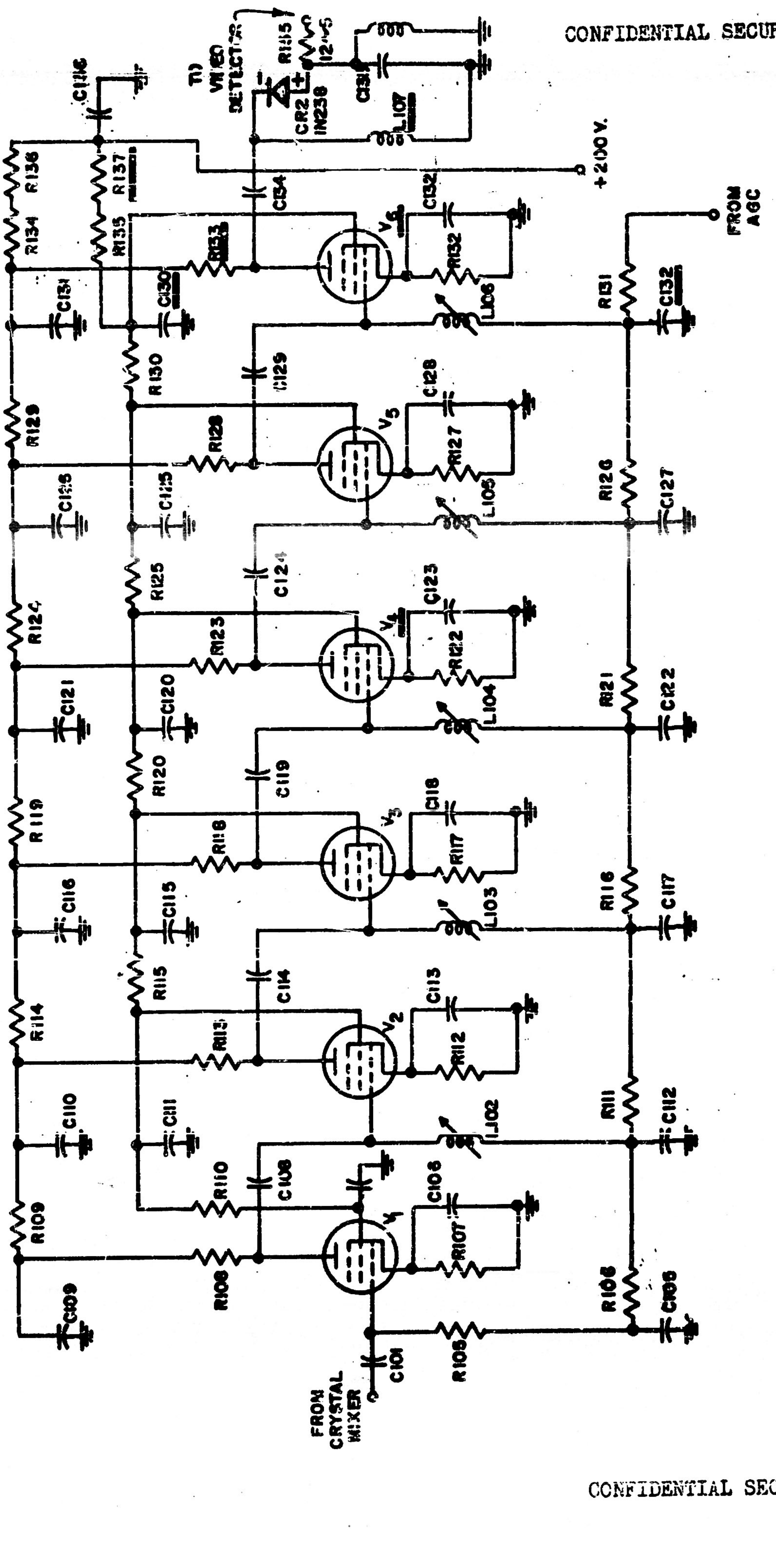
1. The video detector circuit of TERRIER is shown above. Which of the following waveshapes best represents the output of the detector if the IN21B crystal is defective? (i.e., front to back ratio is unity)






2. Crystal CR 8 in the above circuit is defective (both front and back resistance values are low). With the normal waveshape at the input terminals as shown, which one of the following waveshapes would appear at the output terminals?

1 2 3 4



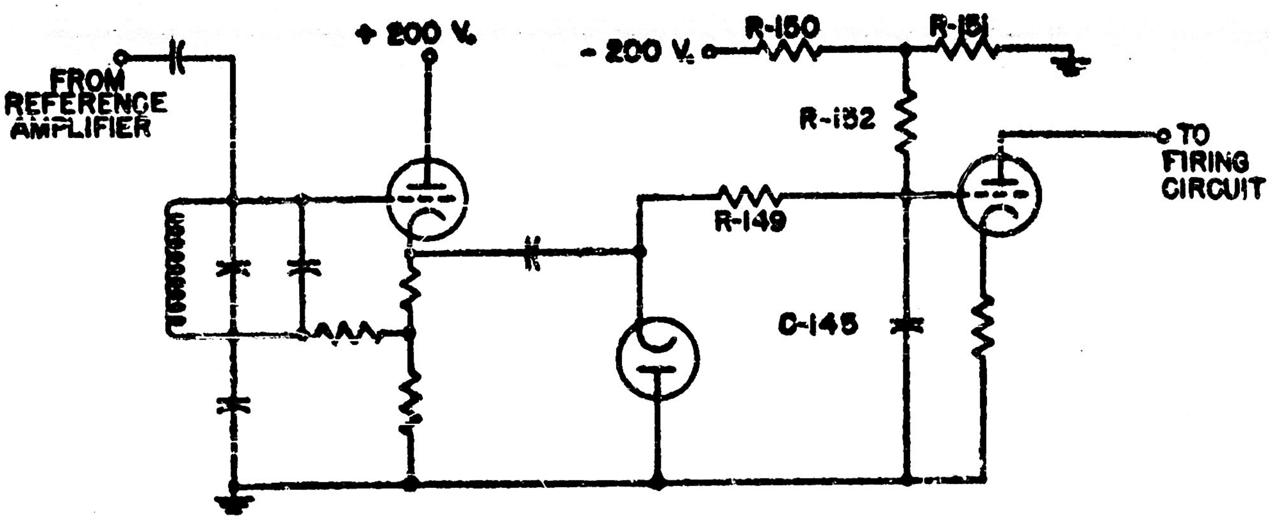
SCHEMATIC DIAGRAM I.F. STRIP

3. Condenser C-132 in the diagram on the opposite page is shorted. If the amplitude of the 45 mc input pulse to the I.F. strip is increased from 20 micro volts to 80 micro volts, the output pulse amplitude will:

1. become zero.
2. remain constant.
3. increase by a factor of four.
4. increase by a factor of two.

4. In the TERRIER I.F. amplifier circuit shown on the opposite page, the filament of V-4 opens up. Which of the following possible results obtained on the Monitoring Panel would indicate this defect?

1. Reference low, error zero.
2. Reference low, error normal.
3. Error low, reference zero.
4. Error low, reference normal.




5. Increasing the capacitance of C-145 in the TERRIER Flight Limiter Circuit shown above lengthens the destruct time. Which one of the following changes would produce the same effect?

1. An increase in R-149.
2. A decrease in R-150.
3. An increase in R-151.
4. An increase in R-152.

6. The crystal mixer in the receiver package is suspected of being defective. Only a VTVM is available to check the crystal. Which one of the following conditions indicates that the crystal is probably good?

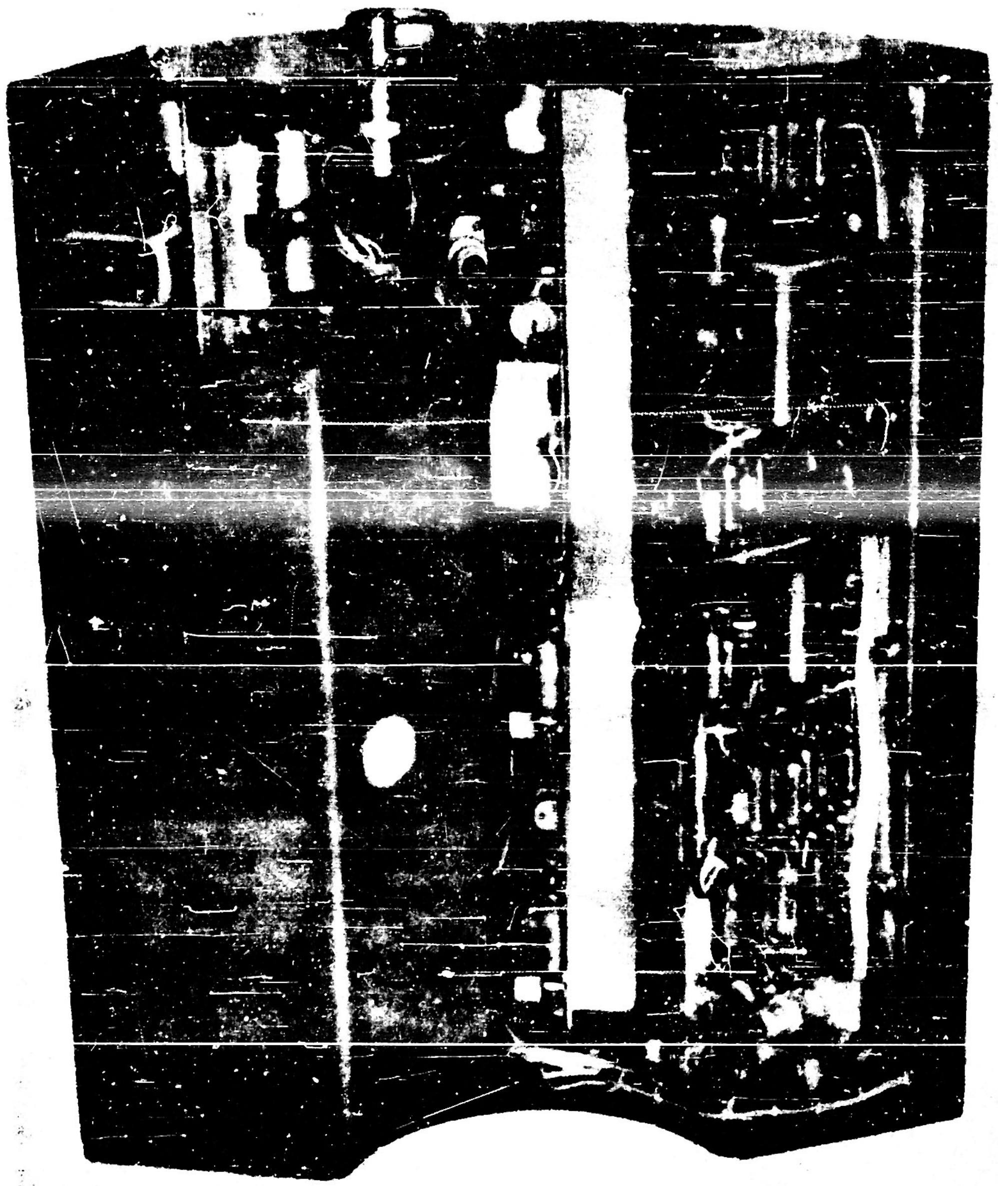
   1. High backward and a high forward resistance.
   2. Zero backward and a low forward resistance.
   3. High backward and a low forward resistance.
   4. Zero backward and zero forward resistance.

7. While a TERRIER missile is in flight, the 30 cps output voltage of the error detector increases from 0.1 volt to 0.6 volts. When this occurs, the missile is:

   1. deviating farther from beam center.
   2. approaching its target.
   3. rolling from flight attitude.
   4. slowing down.

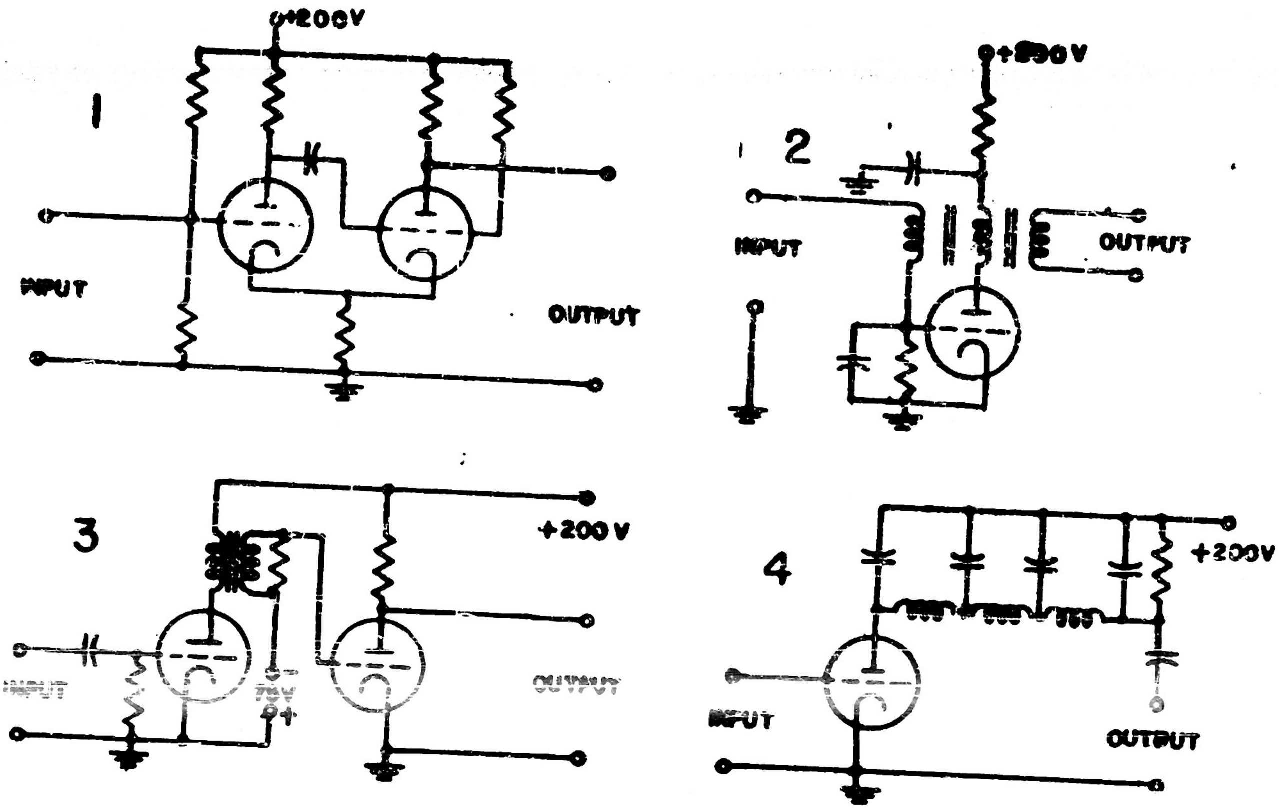
8. A missile is launched and does not follow the beam. An inspection of the telemetering record shows zero signal on the A.C.C., 30 cps reference, and 30 cps error channels. Which one of the following possible defects could account for the missile failure?

   1. Gyro failed to uncage.
   2. Programmer failed to operate.
   3. Local oscillator is defective.
   4. Reference demodulator (discriminator) is defective.



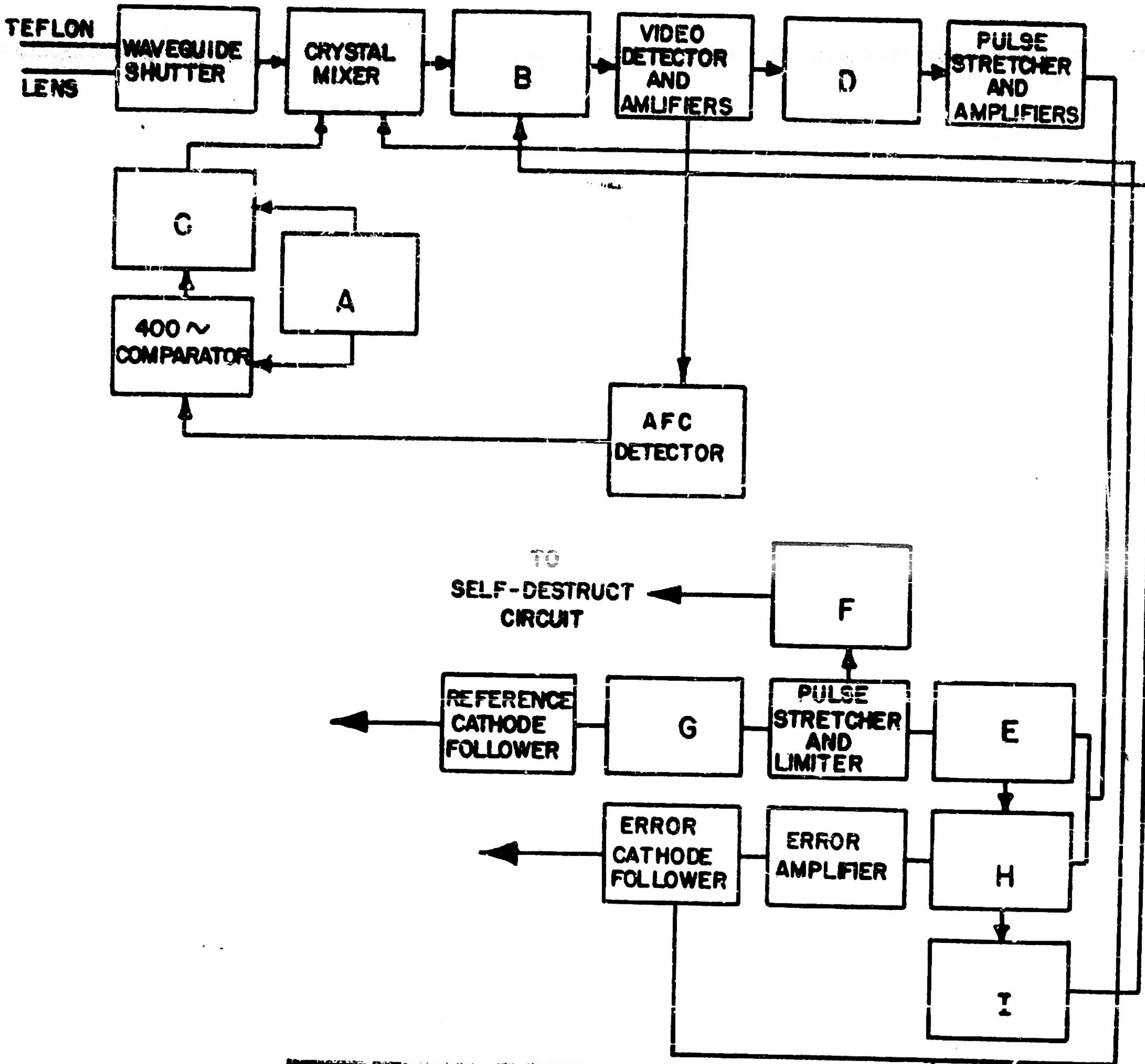
2. The large box in the lower left of the assembly shown above contains which of the following circuits?

1. The demodulator
2. The I.F. chassis
3. The delay line
4. The local oscillator




**10.** **Which one of the circuits shown above most nearly resembles the blocking oscillator used in the TERRIER receiver?**

1. 1
2. 2
3. 3
4. 4




SUPERHET RECEIVER BLOCK DIAGRAM

11. In the block diagram of the TERRIER receiver shown above, block A represents the:

1. I.F. strip.
2. 400 cycle source.
3. local oscillator.
4. 400 cycle discriminator.

12. In the block diagram of the TERRIER receiver shown on the opposite page block D represents the:

1. AGC network.
2. blocking oscillator.
3. decoder.
4. flight limiter.

13. The response curve (band pass characteristics) of the I.F. strip in a TERRIER superhet receiver is made approximately square as shown in Figure A instead of peaked as shown in Figure B. Which of the following receiver systems would not operate properly?

1. AGC.
2. AFC.
3. Decoder.
4. Blocking oscillator.

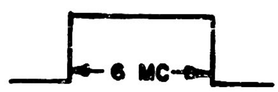
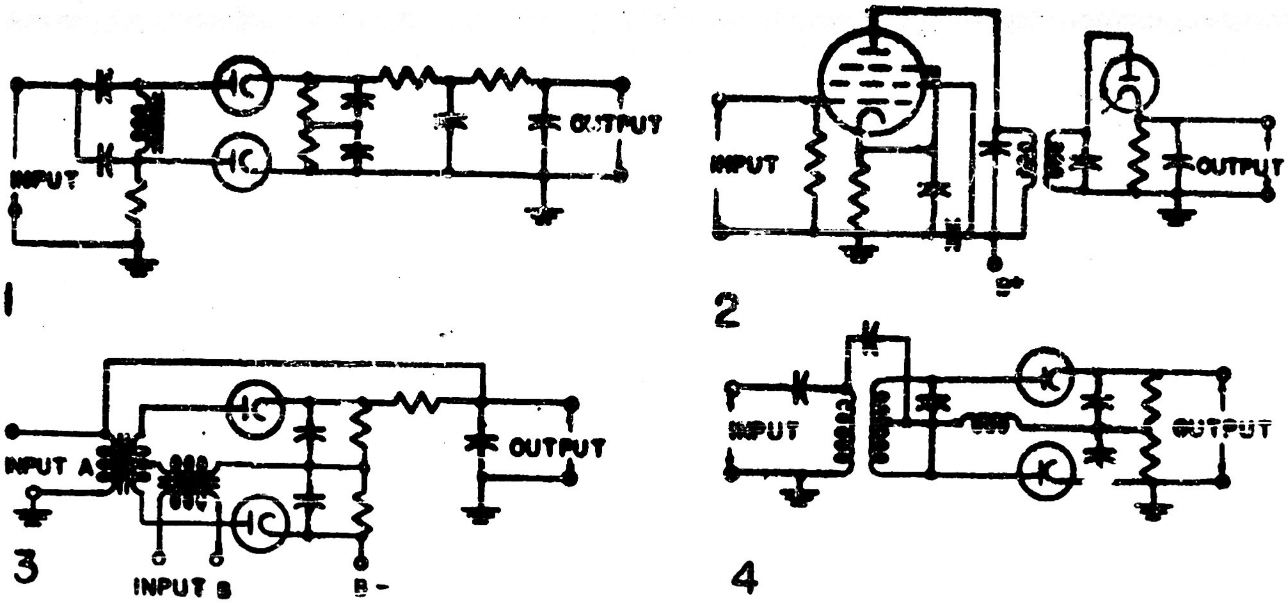


FIG. A

FIG. B

14. As a TERRIER missile moves farther away from the launcher, the AGC voltage does which of the following?

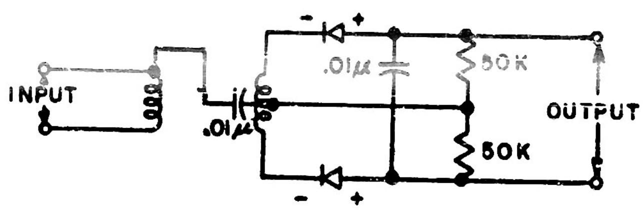
1. Holds the receiver gain constant.
2. Holds the video detector voltage constant.
3. Holds the reference voltage constant.
4. Holds the I.F. frequency constant.



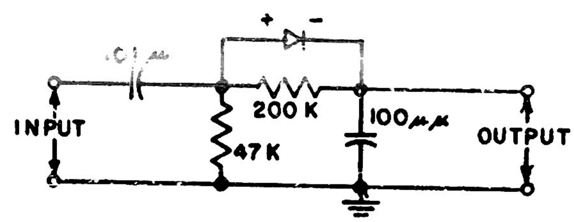

15. Which one of the four detector circuits shown above most nearly resembles the <u>reference discriminator</u> used in TERRIER receivers?

1. 1
2. 2
3. 3
4. 4

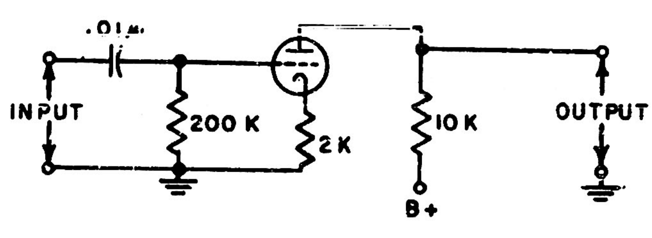
16. The purpose of a pulse stretcher in the TERRIER receiver is to lengthen a 1/4 micro-second pulse into a pulse of much longer duration. Which of the circuits shown below could best perform this function?



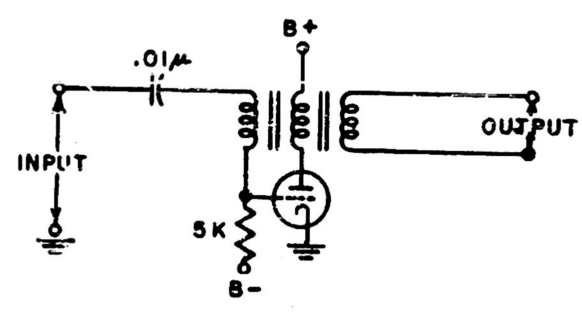

-1-




-2-

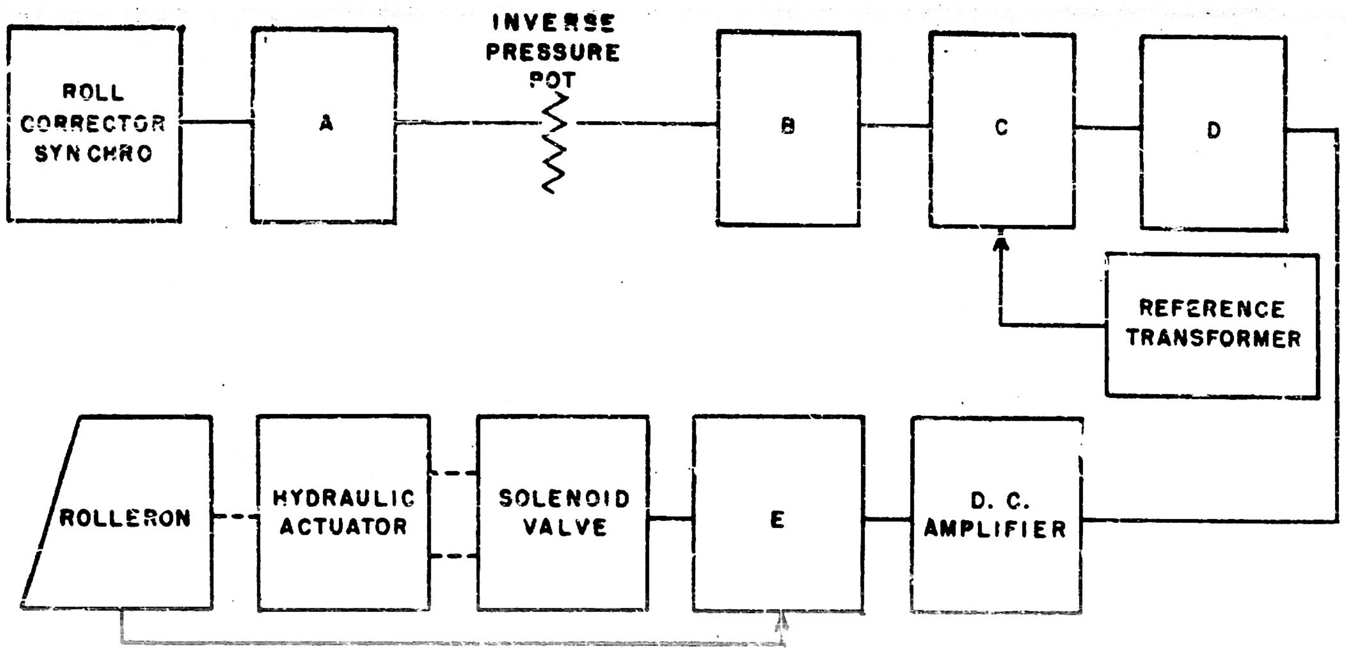



-3-




-4-

# GUIDANCE SYSTEM




17. Block C, in the above diagram, is which of the following?

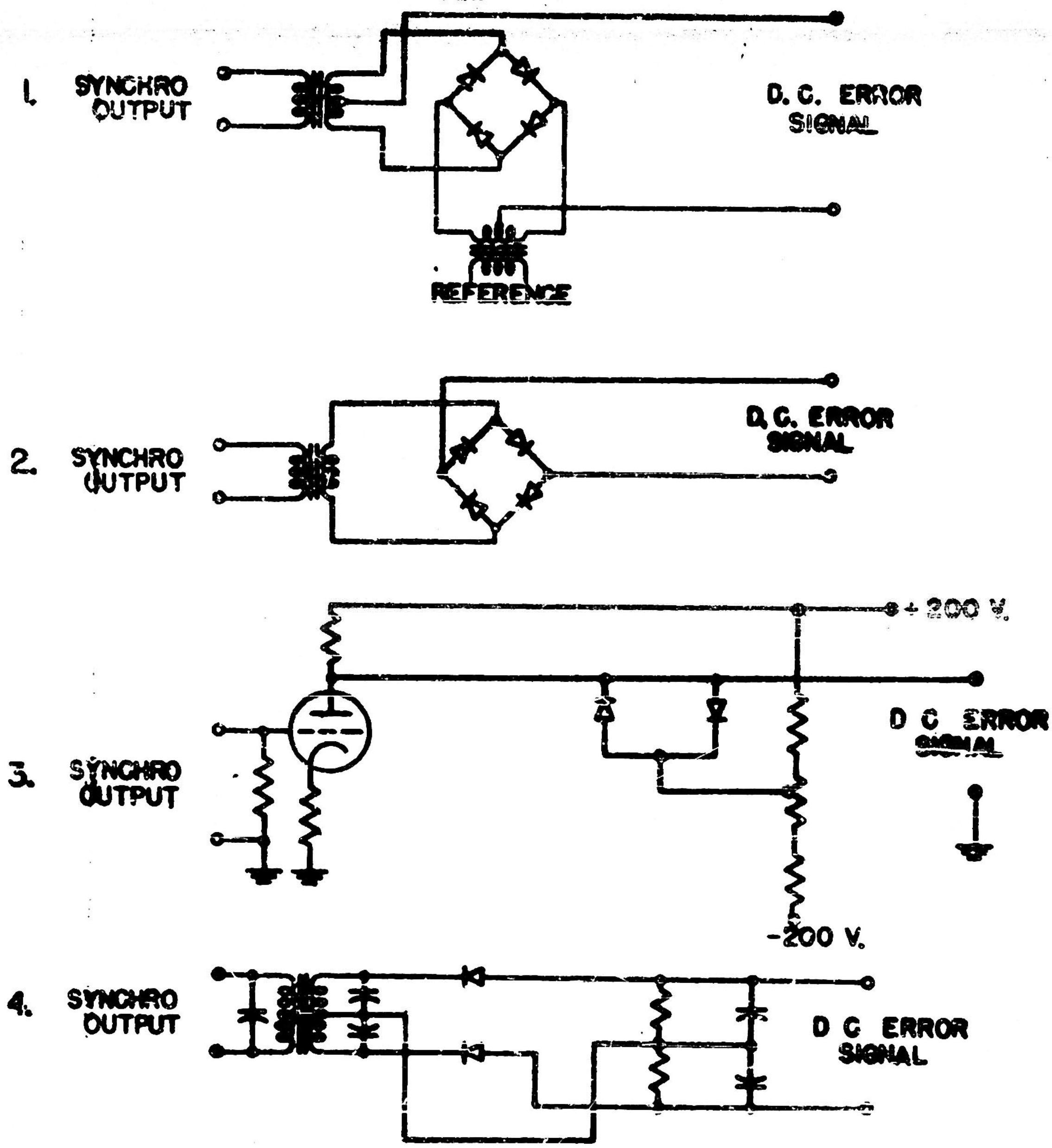
1. Demodulator.
2. Corrective network.
3. Gyro Pickoff synchro.
4. Servo Amplifier.

18. In the block diagram of the roll system shown above, the function of Block D is:

1. to transform the A.C. error and reference signals into a D.C. signal.
2. to control the roll system gain after the boost phase of flight.
3. to prevent oscillation of the missile about its roll axis.
4. to amplify the power of the roll error signal.

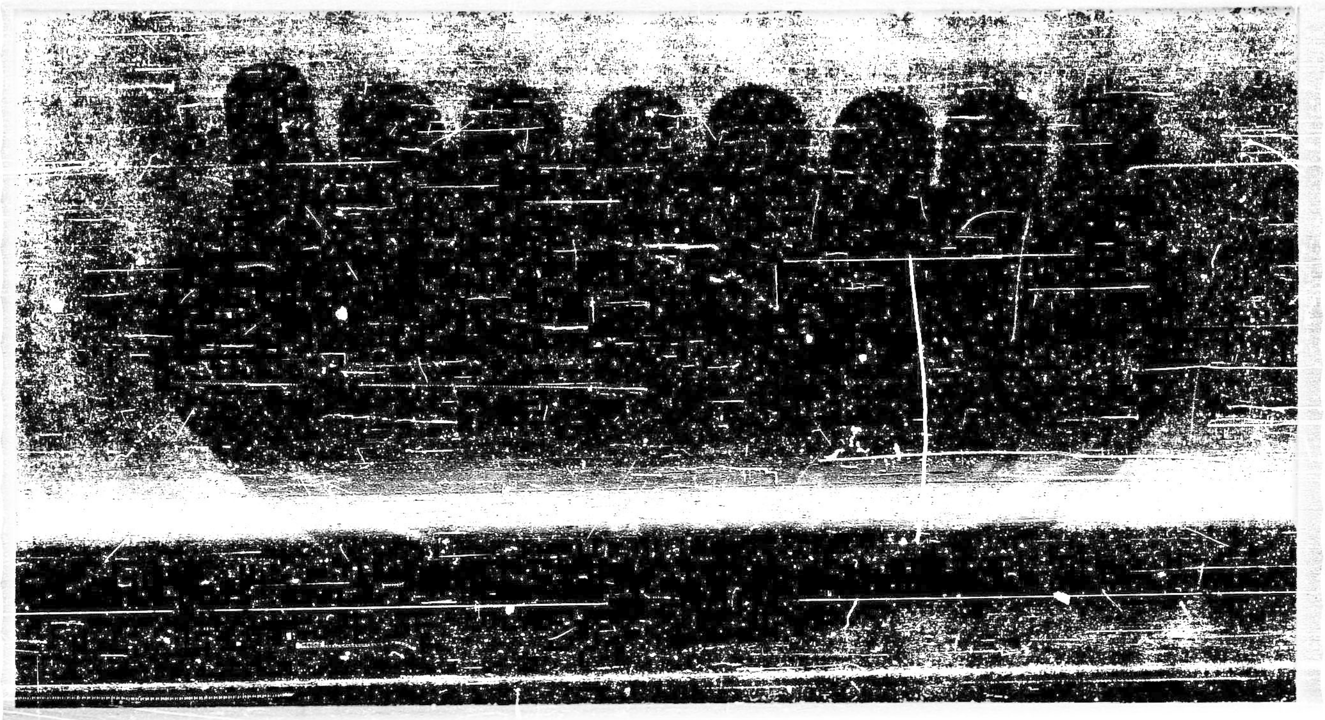
19. Select, from the choices given below, the one which correctly describes the operation of the TERRIER Roll Synchro System prior to the closing of the last firing interlock.

| | Roll Free Gyro | Roll Corrector Synchro | Shipboard (launcher) Synchro |
|---|---|---|---|
| 1. | Caged | Positioned by shipboard (launcher) synchro | Driven by ship's computer |
| 2. | Driven by ship's computer | Rotor locked | Positioned by roll free gryo synchro |
| 3. | Caged | Positioned by roll free gyro synchro | Positioned by roll free gyro synchro |
| 4. | Driven by ship's computer | Positioned by signal from roll free gyro synchro and roll corrector synchro | Driven by missile gyro |



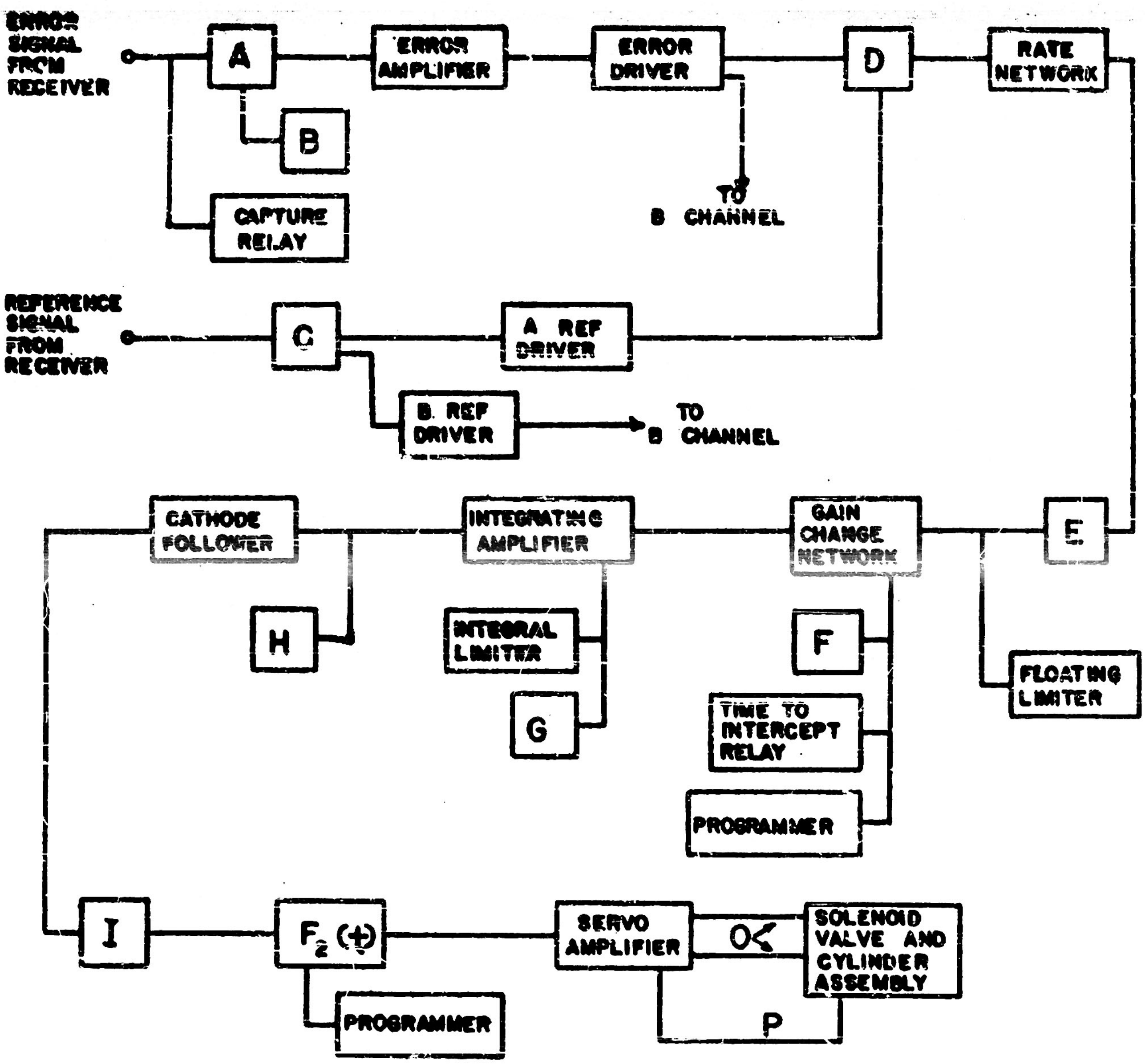

20. In the Roll Stabilization system it is necessary to change the AM 400 cps roll error output of the synchro transformer to a D.C. error signal. The magnitude of this signal is proportional to error and the polarity is consistent with the direction of error.
Which of the circuits shown above would accomplish this?

1. 1
2. 2
3. 3
4. 4



21. The TERRIER component assembly shown above is the:

1. intelligence converter.
2. computer.
3. roll servo amplifier.
4. programmer.




GUIDANCE PACKAGE BLOCK DIAGRAM

Note: In order to simplify the diagram, switching components such as the programmer are shown in more than one block.

The items on this page refer to the block diagram of the guidance package shown on the opposite page. In items 22 to 26 select the answer which correctly identifies the block listed at the left.

22. Block A is the:

1. reference amplifier.
2. programmer.
3. error channel mixer.
4. $F_1(t)$ potentiometer.

23. Block C is the reference signal:

1. phase splitter.
2. amplifier.
3. phase comparator.
4. phase inverter.

24. Block D is the "A" channel:

1. cathode follower.
2. compensated D.C. amplifier.
3. phase comparator.
4. input monitor isolating amplifier.

25. Block F is the:

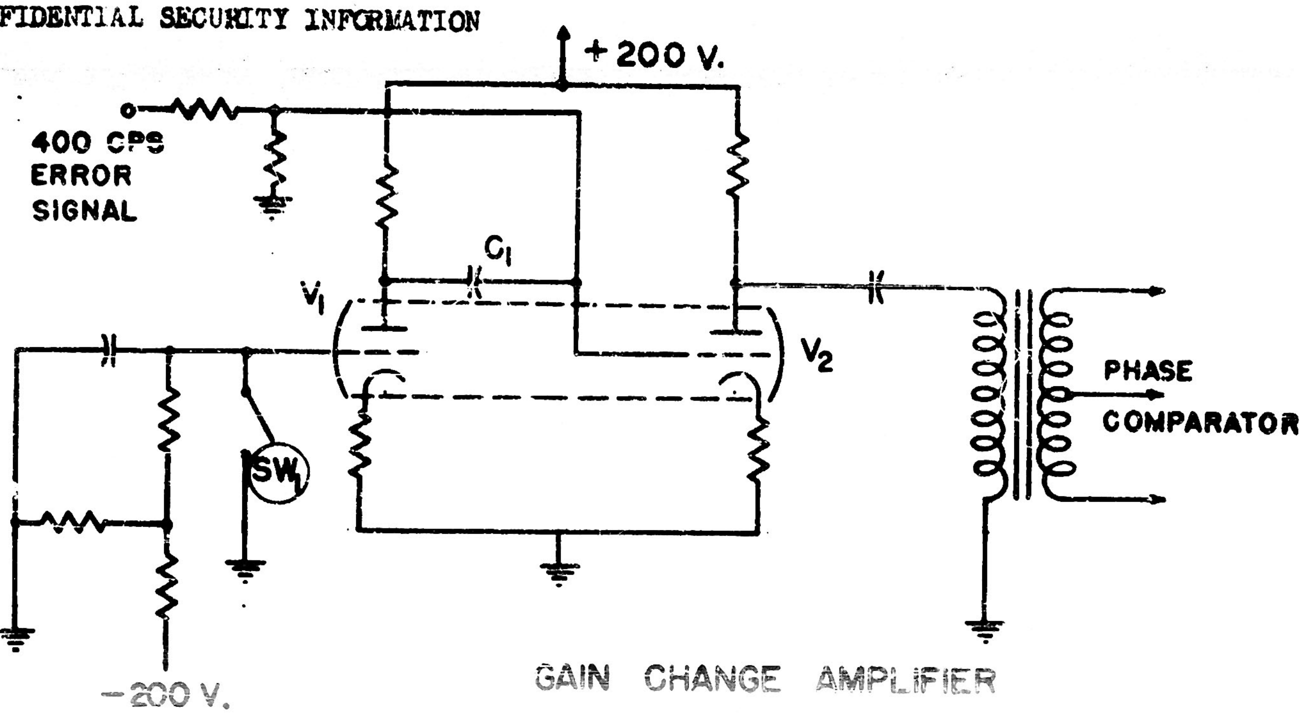
1. flight limiter.
2. capture relay.
3. floating limit control.
4. assymetrical limit control.

26. Block I is the:

1. programmer.
2. inverse pressure potentiometer.
3. fixed limiter.
4. second cathode follower.

27. The connection, marked O, (see opposite page) between the servo amplifier and the solenoid valve represents the push-pull driving connections from servo driver to valve. What does the connection P represent?

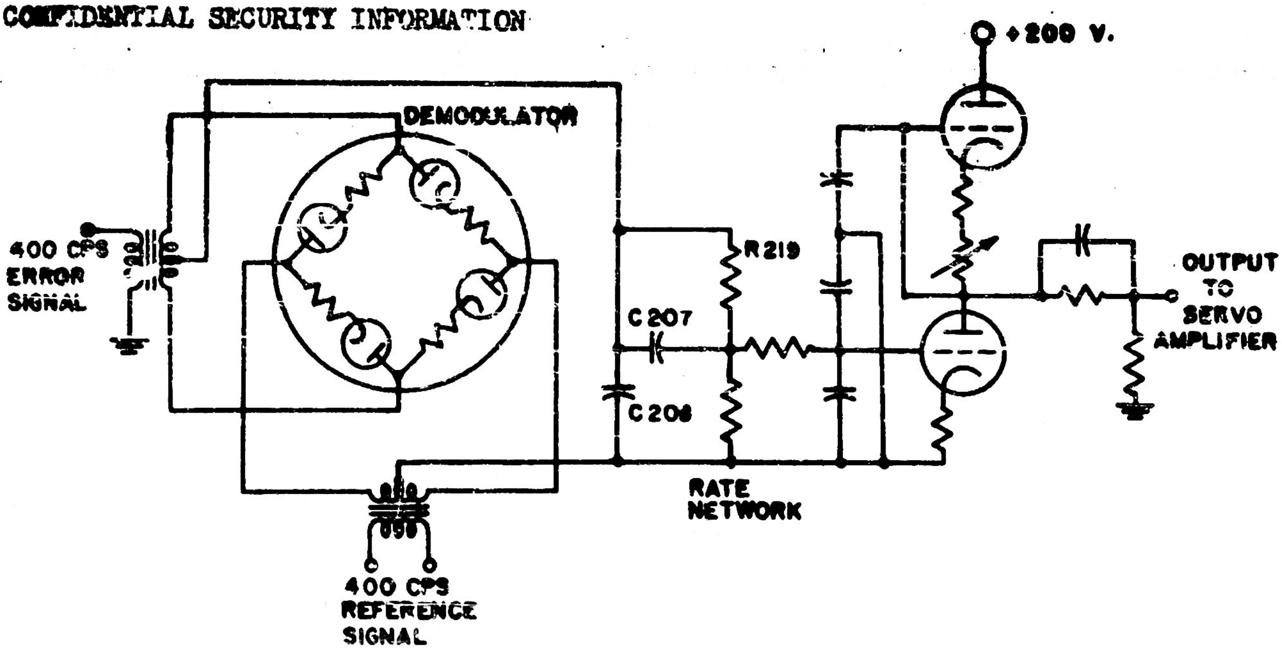
1. The wing trim feedback adjustment.
2. The common ground feedback connection between the valve solenoid center tap and the amplifier.
3. The common B+ plate feedback connection of solenoid and servo amplifier.
4. The feedback position signal from the valve and cylinder assembly to the servo amplifier.




GAIN CHANGE AMPLIFIER

28. The diagram above shows the Roll System Gain Change Amplifier. If switch $SW_1$, which is operated by the programmer, becomes defective and remains closed during flight, the missile can be expected to:

1. roll without any control.
2. respond more slowly than normal.
3. maintain a fixed roll position deviating from normal.
4. consistently overshoot its normal roll position.




29. A portion of the missile's Roll Stabilization System is shown in the diagram above. The signal output to the servo amplifier carries a large 800 cps A.C. component.
Which of the elements shown in the diagram is responsible for this signal?

1. Capacitor C-207.
2. Resistor R-219.
3. Capacitor C-208.
4. The demodulator.

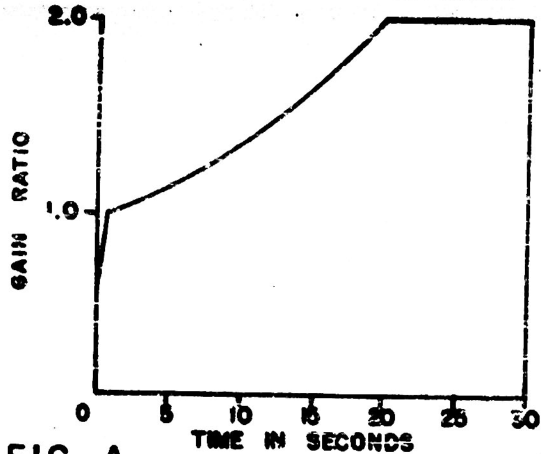



FIG. A

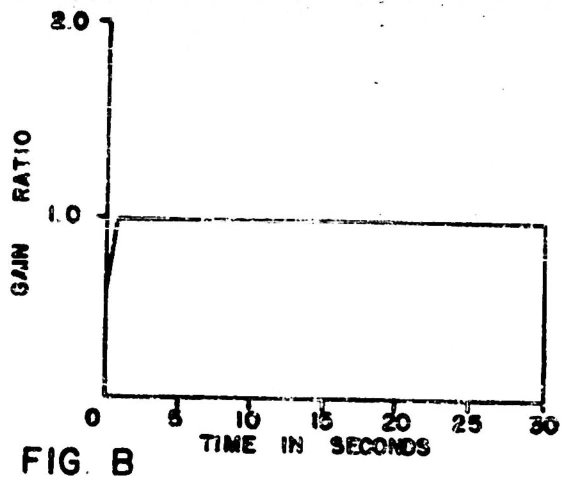



FIG. B

30. A typical change in the overall static gain of the Roll System is shown in Figure A above. If the actual gain change takes place according to Figure B, the system at fault is:

1. the programmer.
2. the receiver.
3. the gain change amplifier.
4. the altitude compensation system.

31. The primary of the transformer supplying power for the Roll Free Gyro opens before the missile is launched. The effect on missile functioning will be such that the missile will:

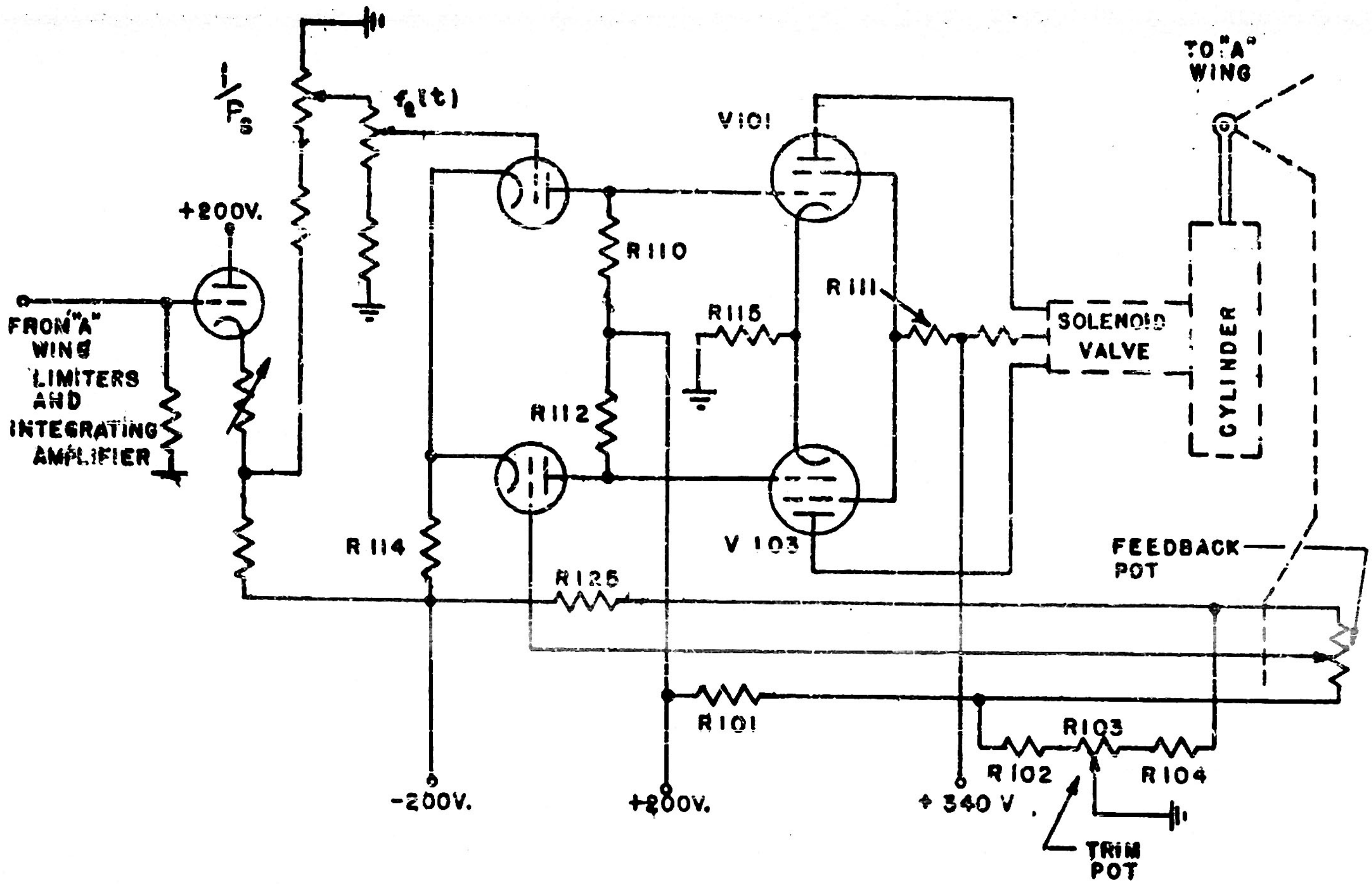
1. not leave the launching platform.
2. maintain the roll position held at the moment of launching.
3. roll continuously in one direction.
4. maintain a roll position 67 1/2 degrees away from position at launching.

32. If the shipboard roll corrector synchro generator is faulty and transmits no signal to the missile prior to its launching, the effect of the malfunction will be to:

1. cause the missile to fly without roll stabilization of any kind.
2. cause the missile to be stabilized in a roll position 67 1/2° CW from its normal roll position.
3. cause the missile to be stabilized in some position not necessarily its normal roll position but depending upon the launcher attitude at the time of launching.
4. prevent the launching of the missile by preventing the closing of the booster squib circuit.

33. The coupling connecting the sylphon (aneroid) bellows to the missile's inverse pressure pots fails. As the missile gains altitude, the effect on missile operation is:

1. a decrease in receiver output.
2. no correction for beam divergence.
3. loss of gain in wing channels and roll stabilization system.
4. no change in gain in wing channels and roll stabilization system due to changes in barometric pressure.




SIMPLIFIED DIAGRAM OF "A" WING COMPUTER CATHODE FOLLOWER AND SERVO AMPLIFIER

34. The connection of the "A" wing static pressure pick-off to ground is open. As a result, the "A" wing will:

1. respond to error signals but will show no variation of wing deflection with atmospheric pressure.
2. respond to error signals but the zero error signal position will be affected by atmospheric pressure variations.
3. move to one or the other stop and remain there.
4. move to the zero position and remain there.

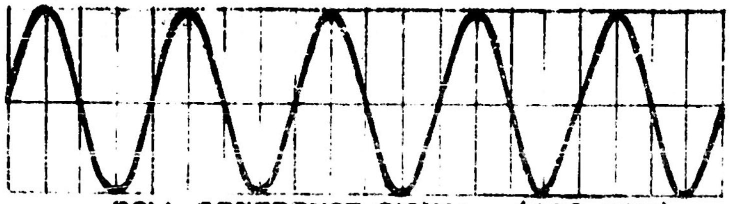
35. One side of the feedback potentiometer connected to the "A" wing (see diagram on opposite page) opens during a flight. As a result the "A" wing will:

1. move to one of the stops and remain there.
2. move to the zero position and remain there.
3. remain actuated but will have no $F_1(t)$ and $F_2(t)$ modification of the wing deflection.
4. remain actuated but will move from one stop to the other as the error signal changes polarity.

36. Failure of the reference voltage transformer in the Roll System results in loss of reference voltage signal to the demodulator. If this occurs the rollerons will:

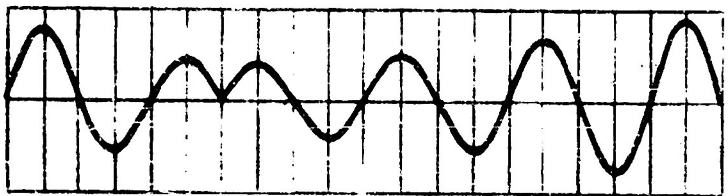
1. move in the desired direction but with a constant position error introduced.
2. move to zero position and remain there.
3. move to the right to their stop and remain in that position.
4. move to the left to their stop and remain in that position.

FIG. 1.



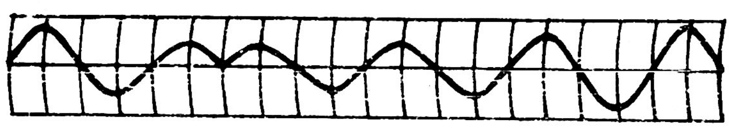
ROLL REFERENCE SIGNAL (400 CPS)

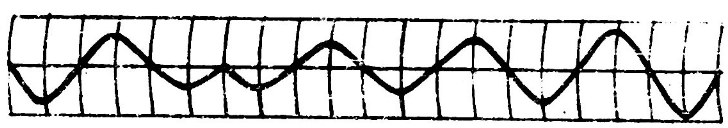
FIG. 2.

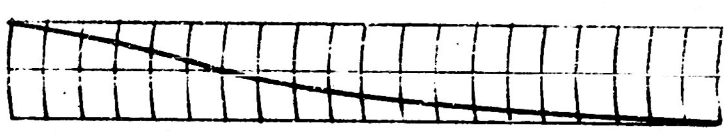


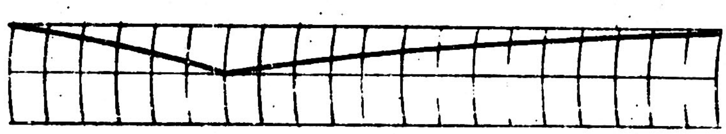
ERROR SIGNAL (ROLL FREE GYRO OUTPUT)

37. During a test of the missile Roll System using the Monitoring Panel, the reference signal shown in Figure 1, and the error signal (Roll input signal) shown in Figure 2 are fed into the Monitoring Panel. The record obtained on the Brush recorder will be:

1. 

2. 

3. 

4. 

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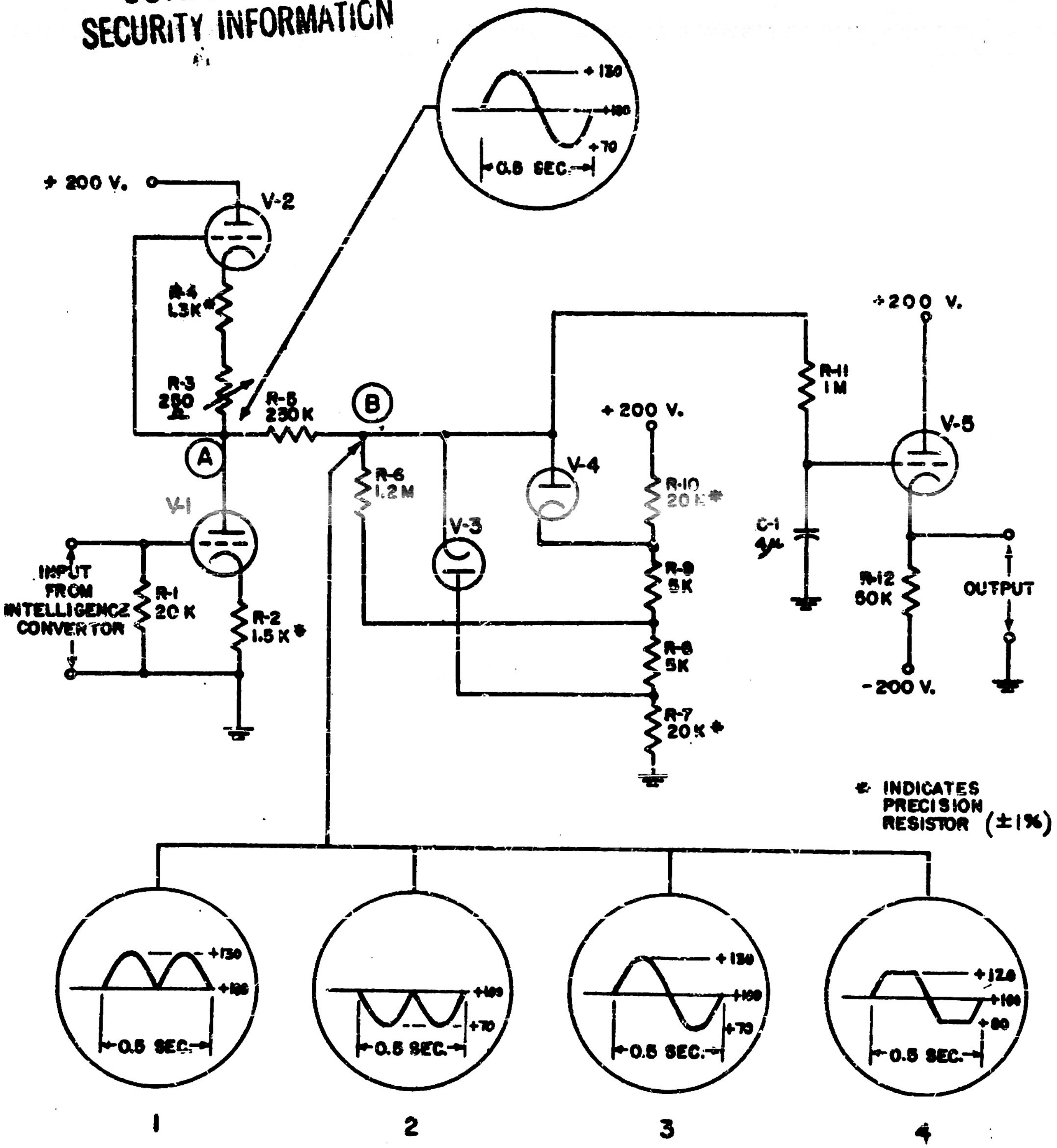


38. The drawing above shows a simplified schematic of the TERRIER computer. When an oscilloscope is connected to point A in the circuit the waveform indicated is obtained. Which of the four scope pictures shown at point B would you expect to see if the circuit were functioning properly?

1. 1 2. 2 3. 3 4. 4

 

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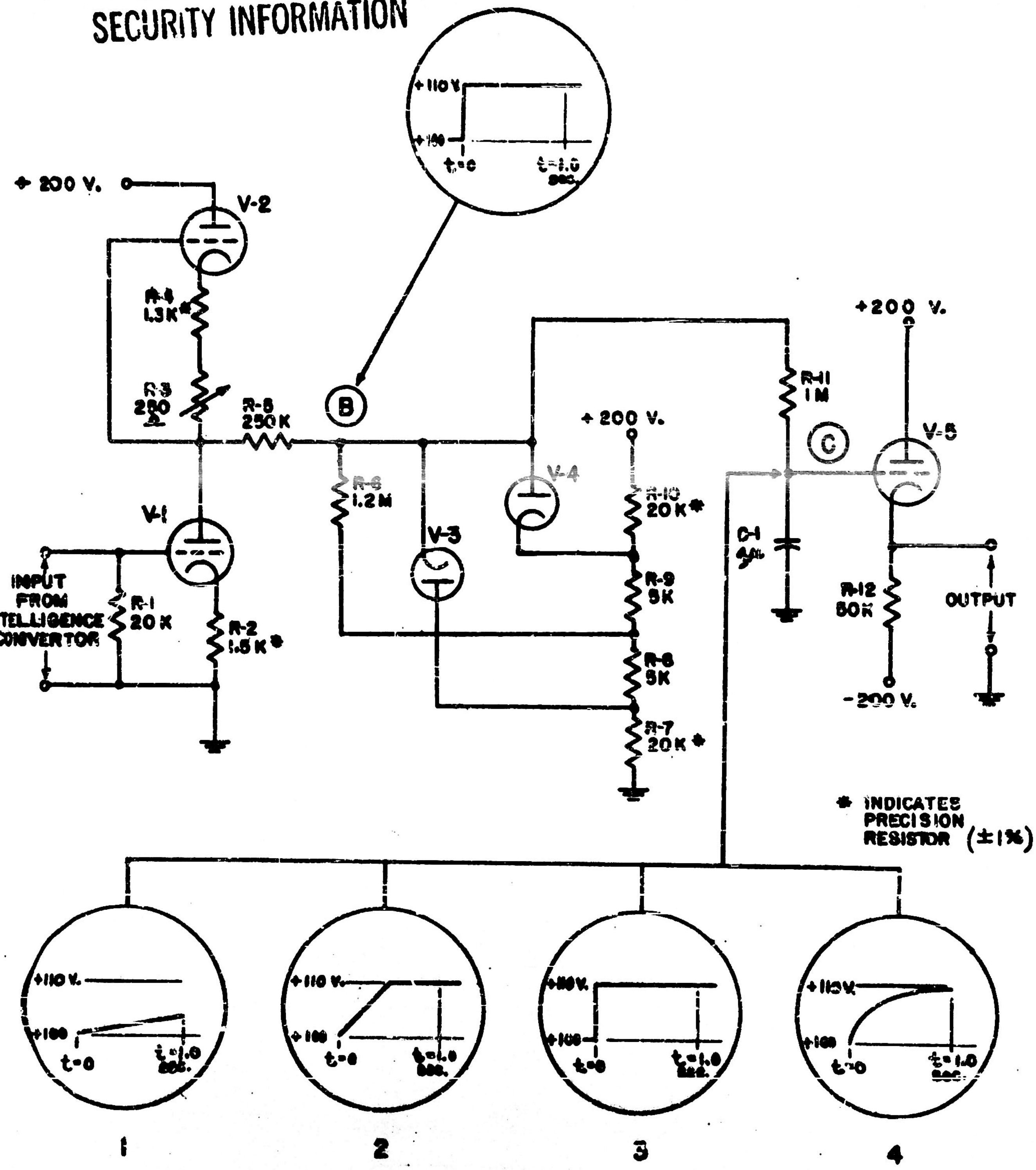


39. The drawing above shows a simplified schematic of the TERRIER computer. When an oscilloscope is connected to point B in the circuit the waveform indicated is obtained. Which of the four scope pictures shown at point C would you expect to see if the circuit were functioning properly?

1. 1 2. 2 3. 3 4. 4



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# PROFICIENCY EXAMINATION
# TERRIER MISSILE
## KNOWLEDGE OF OPERATION : PART B
### EXPERIMENTAL FORM K-2

PREPARED UNDER THE SPONSORSHIP OF THE
BUREAU OF NAVAL PERSONNEL

OFFICE OF NAVAL RESEARCH
CONTRACT NUMBER N7onr-37008, NR-152-079

AMERICAN INSTITUTE FOR RESEARCH
PITTSBURGH, PENNSYLVANIA

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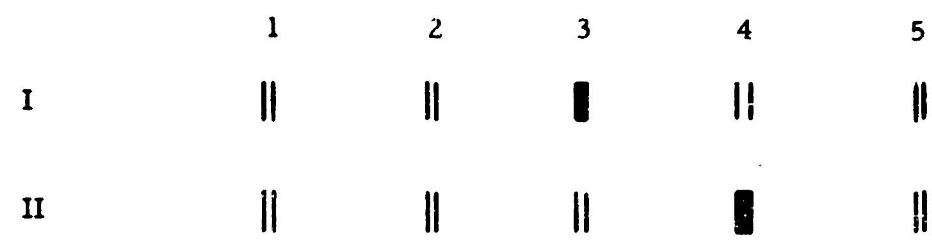
## GENERAL DIRECTIONS: KNOWLEDGE OF OPERATIONS, PART B

This is a test of your knowledge of the principles underlying the operation of the TERRIER missile and its associated test and servicing equipment.

Most of the questions in this test cannot be answered quickly from memory. They require you to think carefully about the problem before you decide on the correct answer. In taking the test you will need to pay special attention to the diagrams which accompany the questions.

Be sure to answer every question in the test, but do not spend too much time on any one problem. Some of the questions are more difficult than others; if you are not completely sure of the correct answer to a problem, make the best guess you can and go on to the next one.

The examiner will instruct you how to fill out the enclosed answer sheet. When doing this print all information that is required. Mark your answers to the problems in this test on this answer sheet. For each question, heavily blacken the space which has the same number as the answer you select, as shown below:

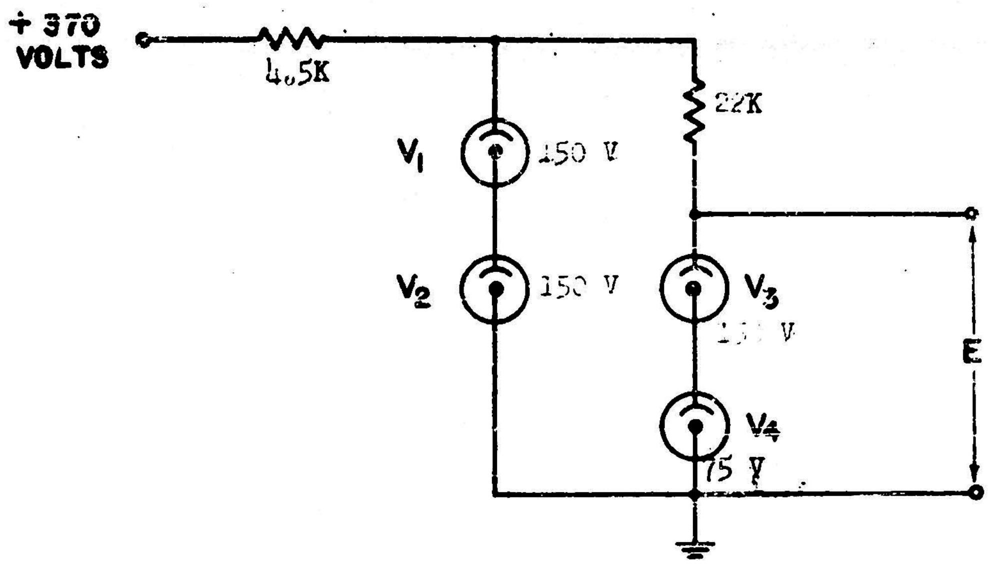



In this example, Answer 3 is marked as being correct for problem I and Answer 4 is marked as being correct for problem II. Mark only one answer for each problem. If you mark two or more answers, neither will be counted as correct.

This answer sheet will be scored by an electrical test-scoring machine. This machine will score your paper accurately only if you use the special pencil that has been supplied, and if you indicate each answer with a solid black pencil mark. Solid black marks are made by going over each mark two or three times and by pressing firmly on the pencil. The test-scoring machine cannot distinguish between intended answers and stray pencil marks or dots. If you want to change any answer already marked, erase the mark completely and then mark the answer desired. Do not cross out a mark. If you are careless in erasing, or if you leave unintentional marks or dots on or near the answer spaces, such marks may be counted by the machine as wrong answers, and your score will be lower than it should be. Do not let your pencil touch any of the answer spaces until you actually mark your answer.

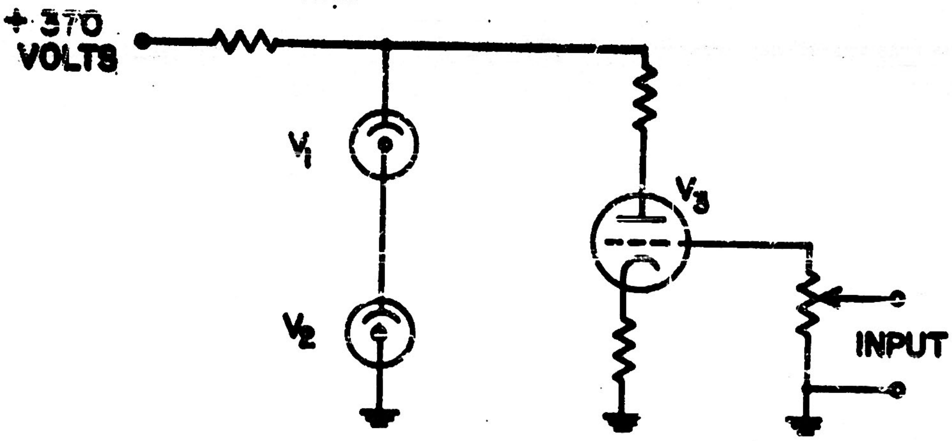
Make no marks on the test booklet. Scratch paper is supplied for you to use in making any drawings or computations you think necessary. Do not turn the next page until you are instructed to do so.

# ELECTRICAL SYSTEM
# (POWER SUPPLY AND SWITCHING)




1. In the above diagram of a section of the missile power supply, tubes $V_1$, $V_2$ and $V_3$ are 150 volt regulator tubes. $V_4$ is a 75 volt regulator. If tube $V_2$ becomes non-conducting, the voltage E will be approximately:

   1. 150 V
   2. 225 V
   3. 300 V
   4. 370 V

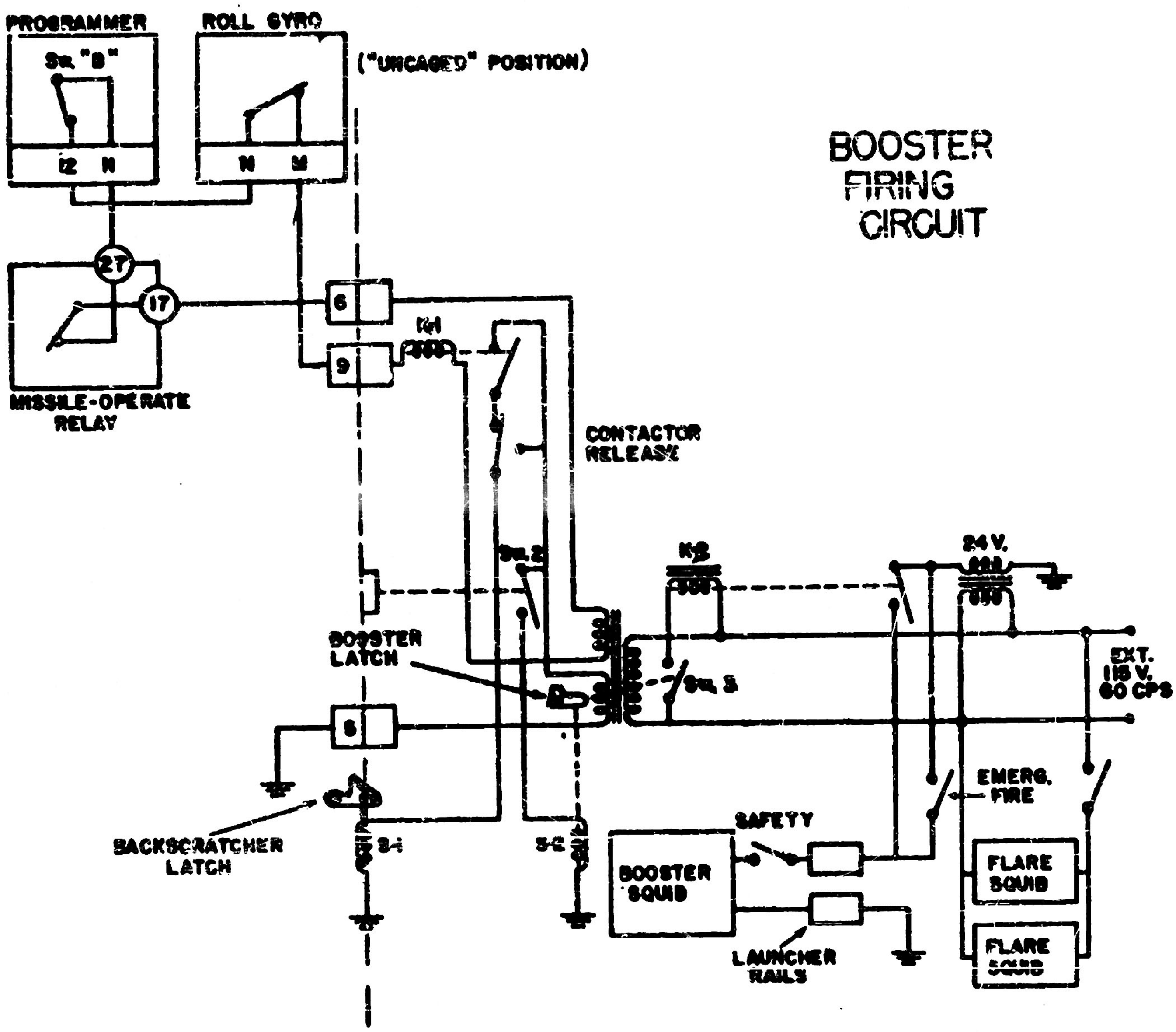



2. In the above diagram of a section of the missile power supply, tubes $V_1$ and $V_2$ are 150 volt regulator tubes. If the cathode connection of tube $V_1$ opens, the plate current of tube $V_3$ will:

1. increase.
2. remain constant.
3. decrease.
4. become erratic.

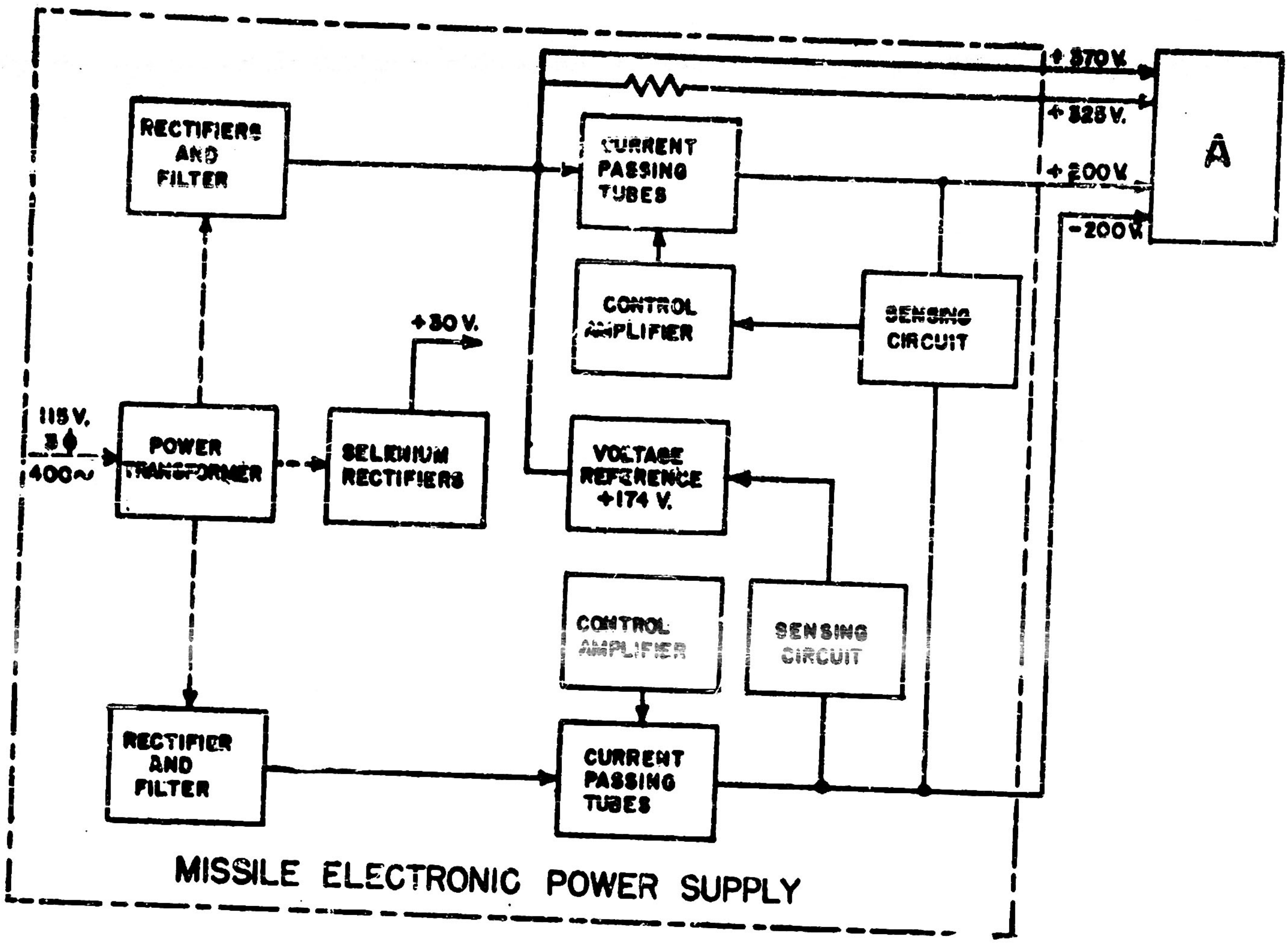
3. The changeover from external to internal power in the missile during launching occurs when:

1. a solenoid relay is energized by the action of the missile operate relay.
2. a solenoid relay is energized by the closing of the last firing interlock contact.
3. the "External-Internal Power" switch is thrown to the "Internal" position.
4. the alternator builds up output voltage.



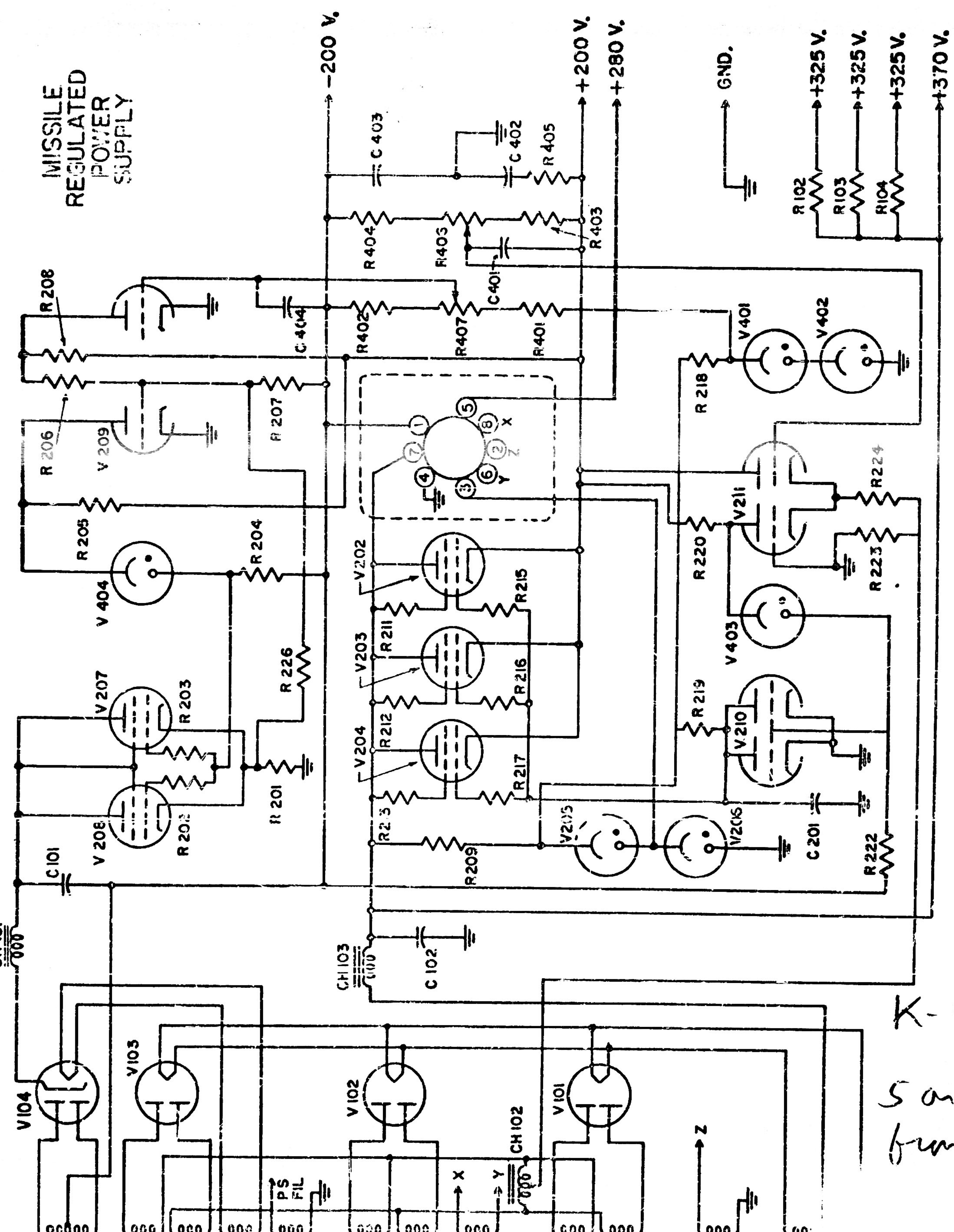

4. The booster firing circuit is shown above. During launching the solenoids are energized in a particular sequence. The correct sequence is:

1. $S_1$, $S_2$, $K_1$, $K_2$
2. $K_1$, $K_2$, $S_1$, $S_2$
3. $K_1$, $S_1$, $S_2$, $K_2$
4. $S_1$, $K_1$, $K_2$, $S_2$




5. A block diagram of the missile power supply is shown above with connections to a missile component identified as block "A". Block "A" represents which of the following missile circuits.

1. Telemeter
2. Klystron local oscillator
3. Programmer
4. Roll servo amplifier




K-13

5 on front

6. If series regulating tube V208 shown in the diagram of the -200 volt regulated supply should fail due to loss of cathode emission, the output of the -200 V supply would be expected to:

   1. remain approximately normal and then gradually become less negative.
   2. remain approximately normal and then instantaneously go to zero.
   3. go to zero and remain there.
   4. go to -100 V. and remain there.

7. A series of checks on the missile regulated power supply shown on the opposite page, indicates the following:

   The -200 volt output is zero volts.

   The +200 volt output is almost zero volts.

   Varying R-406 has no effect on the output of the +200 volt supply.

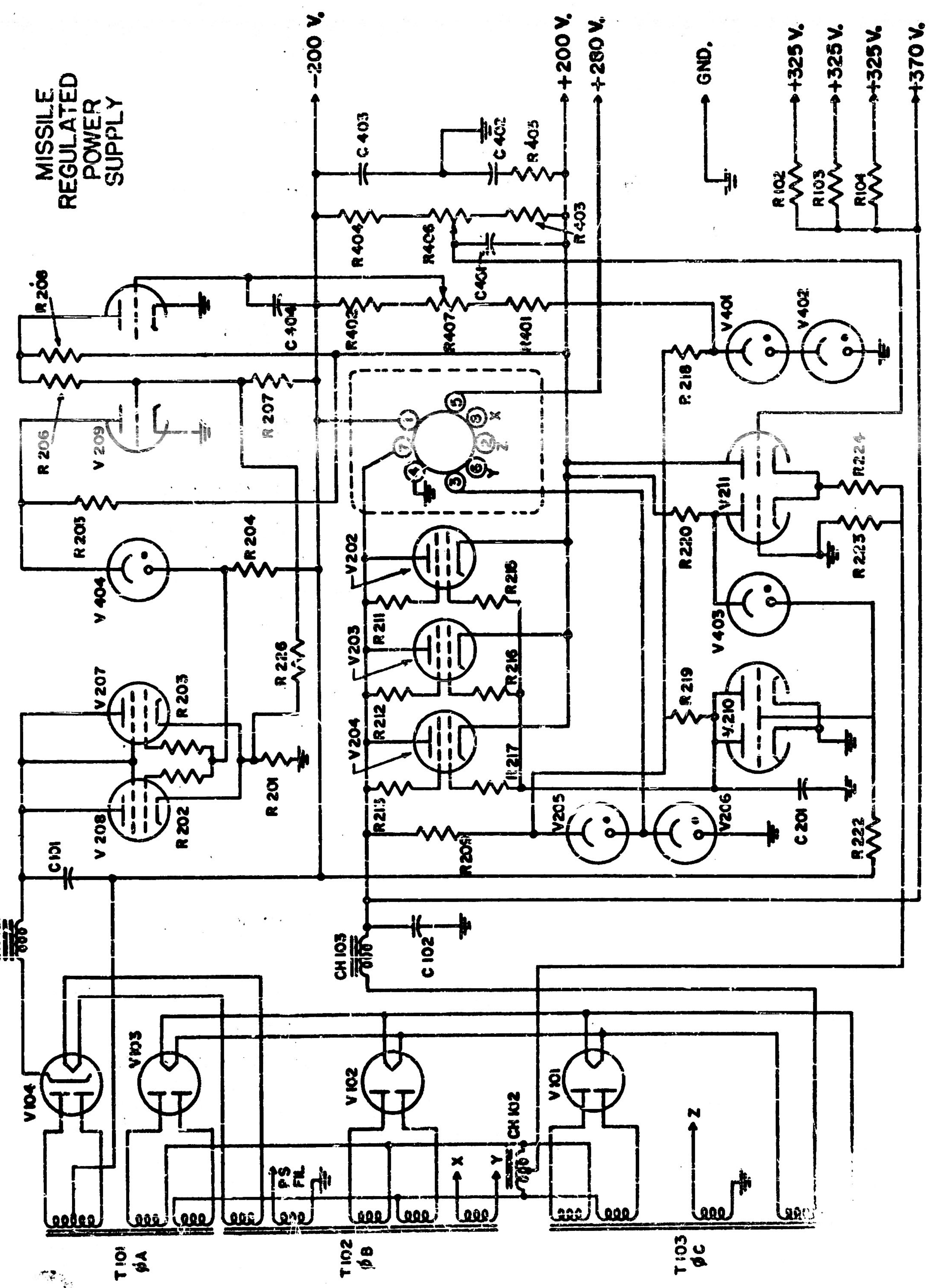
   VR tubes V-403 and V-404 are not conducting.

   The voltage across C-102 is normal (+370 volts).

   The voltage across C-101 is zero.

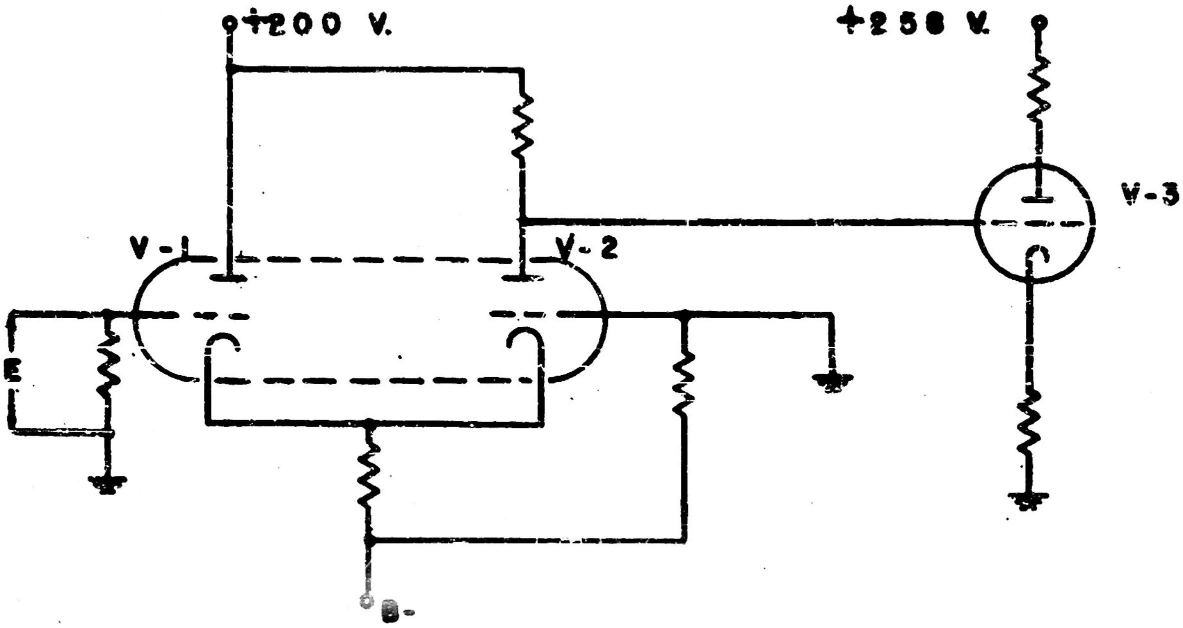
   This trouble can be the result of:

   1. an open primary in transformer T-102
   2. the failure of choke CH-103
   3. the failure of tube V-104
   4. the failure of VR tube V-404


MISSILE
REGULATED
POWER
SUPPLY
-200 V.
+200 V.
+280 V.
GND.
+325 V.
+325 V.
+325 V.
+370 V.
C 403
C 402
R 405
R 404
R 406
R 403
C 404
R 402
R 407
R 401
R 208
R 206
V 209
R 207
R 218
V 401
V 402
R 205
V 404
R 204
R 226
V 202
V 203
V 204
R 211
R 212
R 213
R 215
R 216
R 217
R 209
V 207
V 208
R 203
R 202
R 201
C 101
V 205
V 206
C 201
R 222
R 220
V 211
R 224
R 223
V 403
R 219
V 210
R 102
R 103
R 104
CH 101
CH 103
C 102
CH 102
V 104
V 103
V 102
V 101
X
Y
Z
T 101
ØA
T 102
ØB
T 103
ØC

8. In the diagram shown on the opposite page an open cathode in VR tube V-404 will result in:

1. The probable failure of tubes V-207 and V-208 due to excessive plate dissipation.
2. the probable failure of resistor R-204 due to excessive current flow.
3. an output voltage higher than normal as measured between the -200 V bus and ground.
4. very low output voltage as measured between the -200V bus and ground.




9. The above diagram is a simplified schematic of a portion of the +200 V regulated power supply. When the input voltage is going negative, the voltage at the plate of tube $V_1$ increases. The impedance changes of $V_1$, $V_2$, and $V_3$ are respectively:

| | $V_1$ | $V_2$ | $V_3$ |
|---|---|---|---|
| 1. | increase | decrease | increase |
| 2. | increase | decrease | decrease |
| 3. | increase | increase | dearease |
| 4. | decrease | increase | decrease |

# AIR AND HYDRAULIC SYSTEM

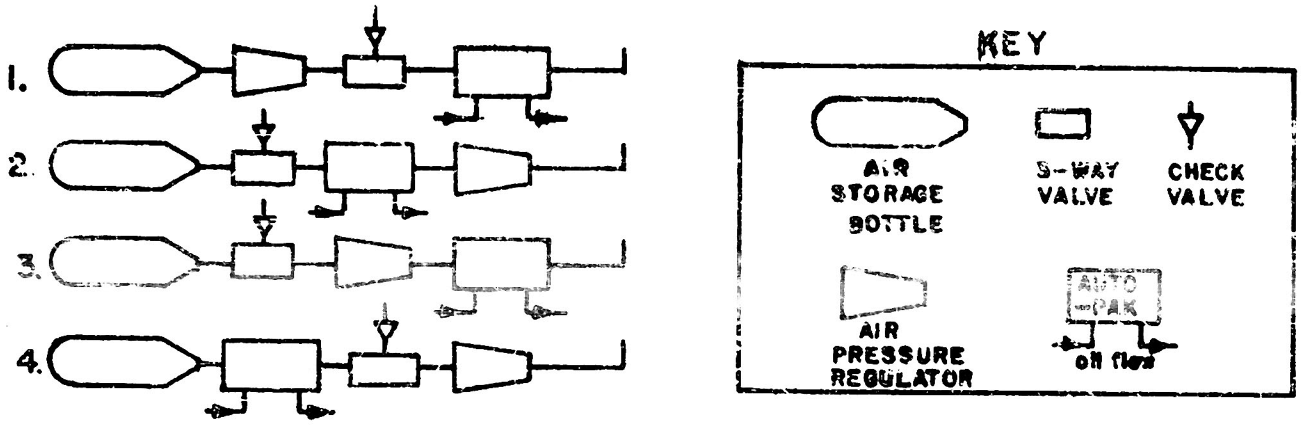
10. If the sump in the hydraulic system were insufficiently charged with nitrogen, the hydraulic system would not operate properly. The reason for this is:

1. the piston would be displaced so as to rupture the oil filter.
2. the operating pressures in the high pressure oil manifold would be too high.
3. the operating pressure in the high pressure oil manifold would be too low.
4. the sump piston would be pushed too far into the low pressure oil manifold.

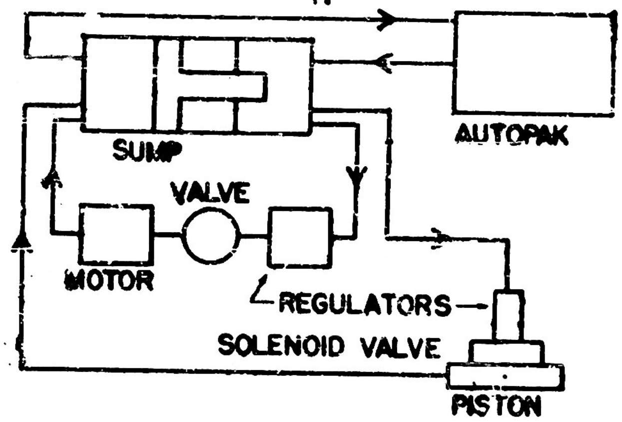
11. If hydraulic oil flow through the rolleron hydraulic actuator were to be completely stopped by dirt in the low pressure oil return line, the rollerons would:

1. float to a neutral position.
2. remain in their present position.
3. be driven to one extreme of their travel.
4. oscillate from one extreme to the other extreme of their travel.

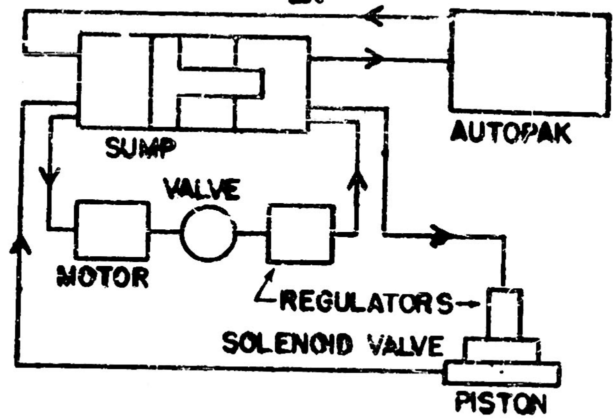
12. The diagrams below represent air supply systems similar to the air supply system of TERRIER. Which arrangement of components permits proper operation of the missile in flight?



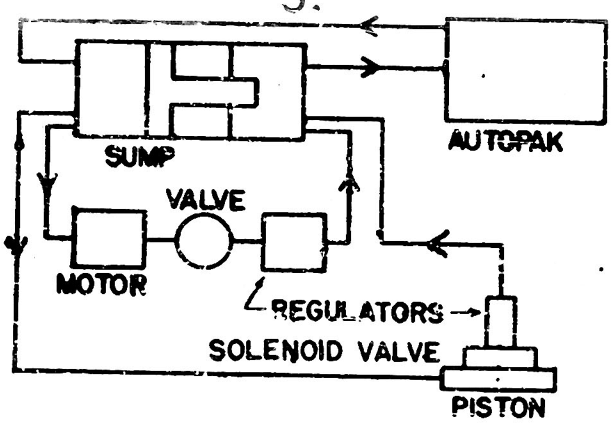
1.



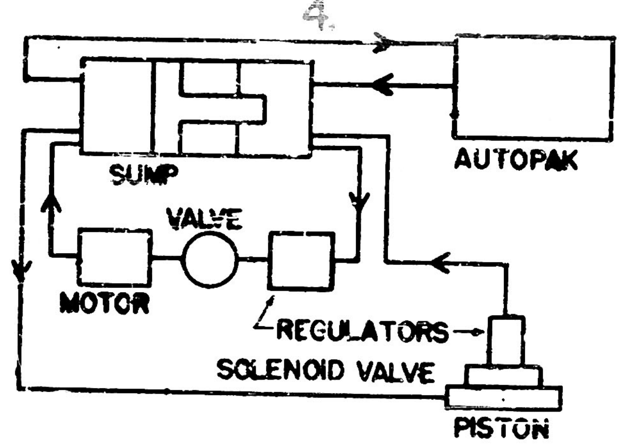

2.




3.




4.




13. The diagrams above are simplified representatives of the TERRIER oil system. Select the diagram which indicates the correct directions of oil flow.

1. 1
2. 2
3. 3
4. 4

14. An autopak system is to be used with a missile having a maximum oil pressure of 600 psi and a regulated air supply pressure of 1600 psi. In this system, the relative sizes of the oil and air pistons would be which of the following:

1. a large oil piston and a small air piston.
2. a small oil piston and a large air piston.
3. either 1 and 2 above since the sump could adjust the oil pressure.
4. an oil piston equal to the air piston.

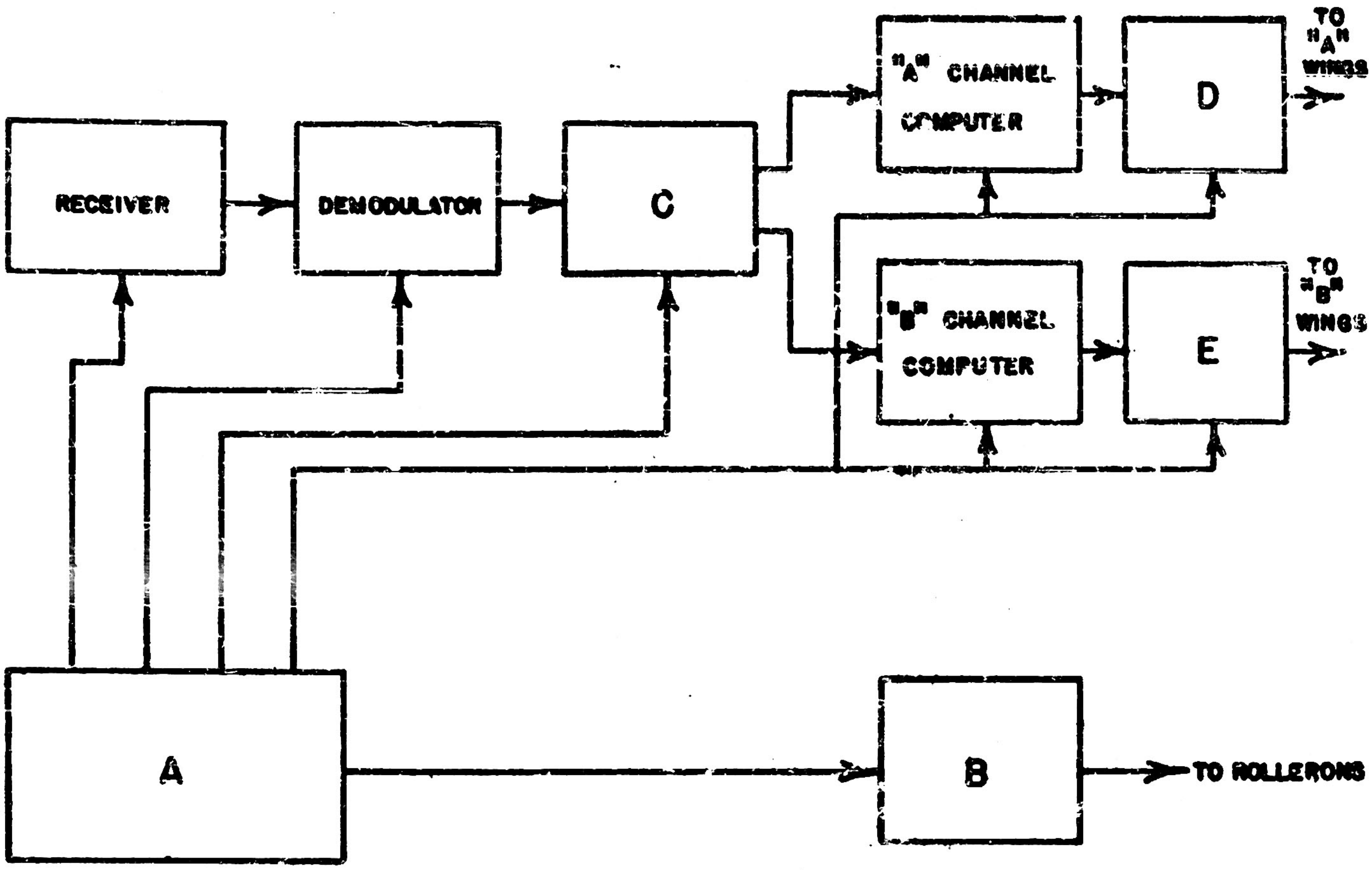
# GENERAL MISSILE SYSTEM

15. An attempt is made to use a missile with the air solenoid inoperative. How would this defect show up?

1. The missile would go out of control after booster separation.
2. The missile would not assume proper roll attitude during booster phase.
3. The back scratcher would eject but the missile would not launch.
4. The back scratcher would not eject and the missile would not launch.

16. In checking the Regulated Power Supply, both the positive and negative regulated D.C. output voltages are within tolerance. However, the input voltages to the regulator circuits are higher than normal. The component most likely to cause this difficulty is:

1. the power transformer.
2. the hydraulic motor flow regulator.
3. the alternator.
4. the autopak.

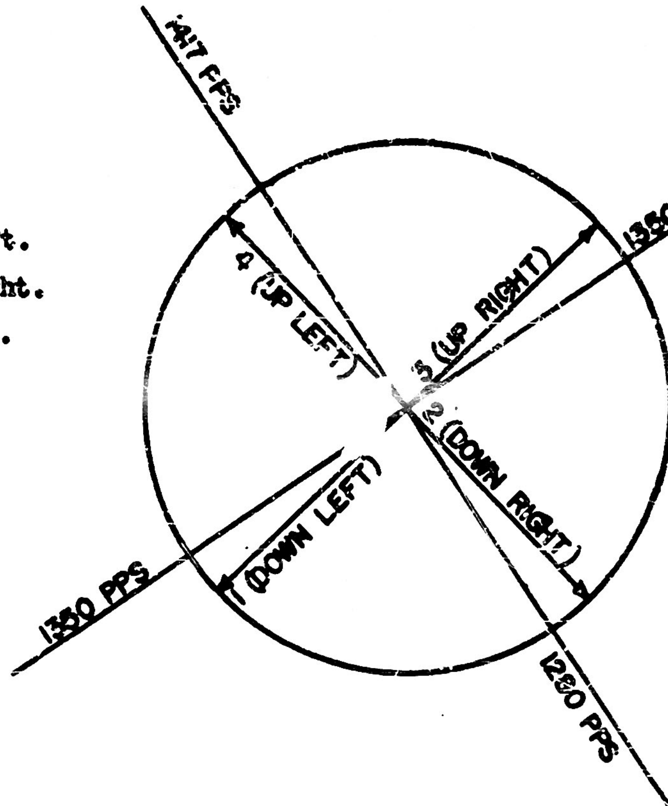



17. In the above block diagram of TERRIER, Block C is which of the following?

1. "A" Channel Servo Amplifier.
2. Roll System.
3. Power Supply.
4. Intelligence Converter.

18. A missile is in flight. The 30 cps error signal, as measured at the output of the receiver, leads the 30 cps reference signal by 10°. In which direction, indicated in the figure below, would the missile be deviating from beam center?

1. Down left.
2. Down right.
3. Up right.
4. Up left.



# HYDRAULIC CHARGING UNIT

19. Hydraulic oil to be charged into a missile is filtered in the charging unit by pumping it:

1. from the sump through the reservoir to the filter.
2. from the reservoir through a filter to the sump.
3. from the sump through a filter and back to the sump.
4. from the reservoir through a filter and back to the reservoir.

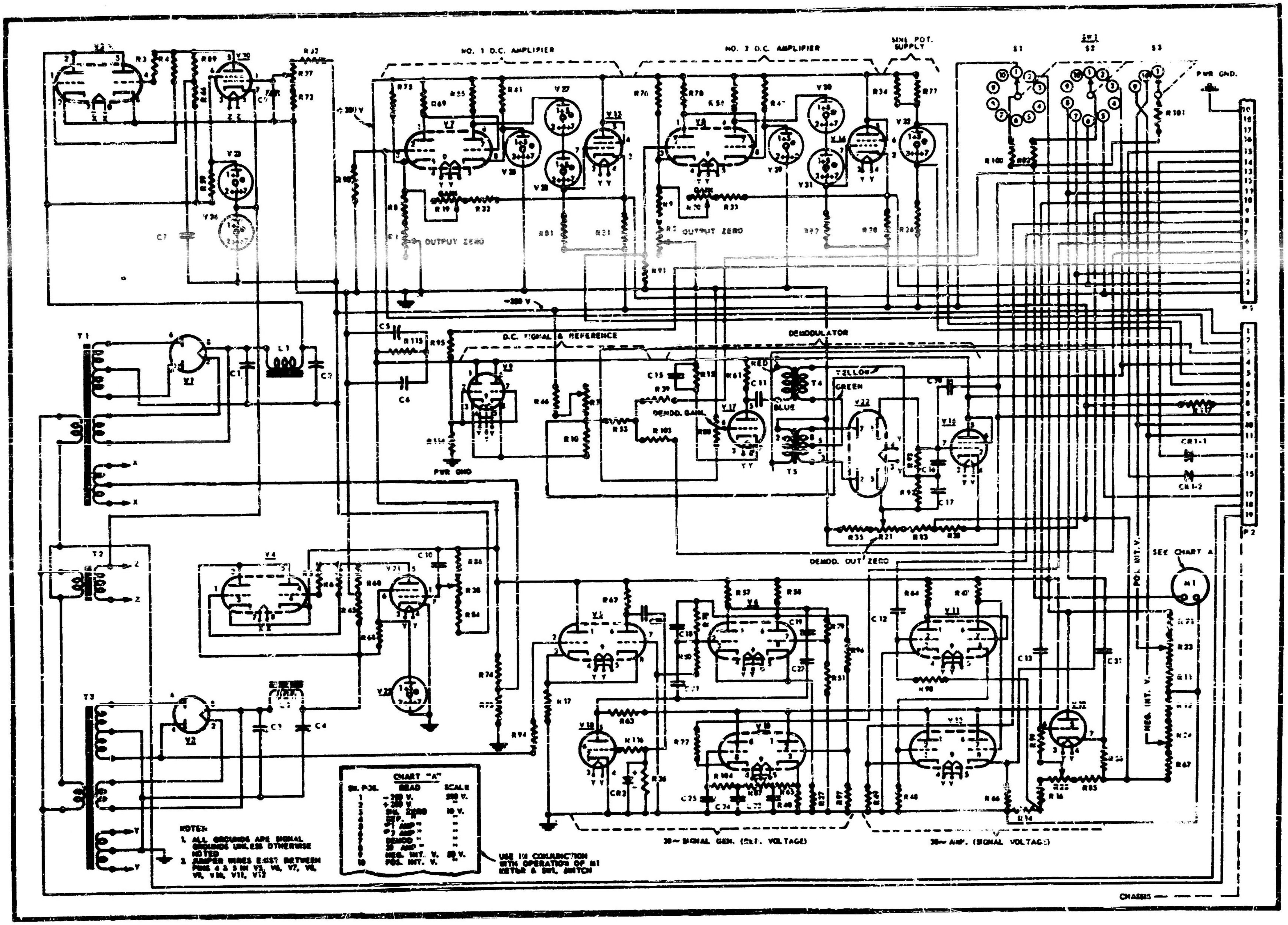
20. The Hydraulic Charging Unit is to be filled. If the Air Valve is left in the ON position, which of the following malfunctions would occur?

1. The vacuum pump would not develop a vacuum in the sump when the pump is operated.
2. The oil picked up when the shut-off valve is opened would flow through the missile connection oil filter.
3. The air pressure regulator would be overloaded by the pressure built up across it.
4. The air filter would be fouled by the flow of oil through it.

21. The missile sump is charged with nitrogen at 1050 psi. After the hydraulic system is charged with oil the sump piston sticks. To correct this the sump is bled and recharged with nitrogen. The recharging nitrogen pressure should be:

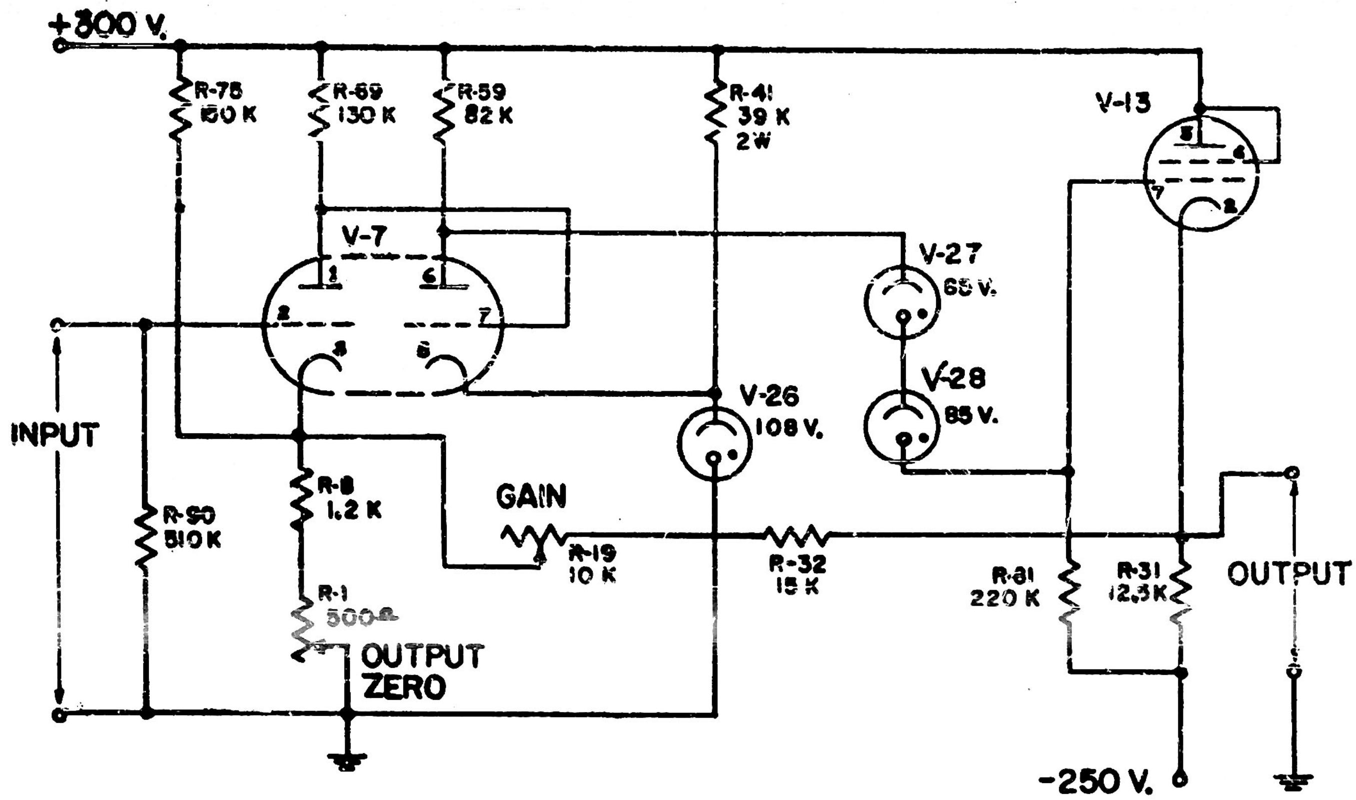
1. 1000 psi because the nitrogen volume is smaller when recharging.
2. 1000 psi because the nitrogen volume is larger when recharging.
3. 1090 psi because the nitrogen volume is smaller when recharging.
4. 1090 psi because the nitrogen volume is larger when recharging.

# MONITORING PANEL


NO. 1 D.C. AMPLIFIER
NO. 2 D.C. AMPLIFIER
SINE POT. SUPPLY
S1
S2
S3
PWR GND.
OUTPUT ZERO
OUTPUT ZERO
D.C. SIGNAL & REFERENCE
DEMODULATOR
DEMOD. GAIN
DEMOD. OUT ZERO
PWR GND
YELLOW
GREEN
BLUE
RED
SEE CHART A
POS. INT. V.
NEG. INT. V.
30~ SIGNAL GEN. (REF. VOLTAGE)
30~ AMP. (SIGNAL VOLTAGE)
CHASSIS
CHART "A"
SW. POS.
READ
SCALE
NOTES:
1. ALL GROUNDS ARE SIGNAL GROUNDS UNLESS OTHERWISE NOTED
2. JUMPER WIRES EXIST BETWEEN PINS 4 & 5 IN V3, V6, V7, V8, V9, V10, V11, V12
USE 1/4 CONJUNCTION WITH OPERATION OF M1 METER & SW. SWITCH

22. A diagram of the Monitoring Panel Electronic Chassis is shown on the opposite page. If the filament of tube V-3 burns out the meter M-1 will give out-of-tolerance readings on switch position(s):

1. 1
2. 1, 2
3. 1, 2, 9, 10
4. All positions




MONITORING PANEL D. C. AMPLIFIER

23. The schematic shown above represents the circuit of one of the Monitoring Panel D.C. amplifiers. The GAIN control R-19 performs its function by:

1. varying the D.C. cathode potential of the first amplifier stage.
2. varying the amount of degenerative feedback to the first amplifier stage.
3. varying the cathode potential of output stage.
4. varying the amount of input signal by-passing the second amplifier stage.

24. All of the following pieces of equipment are required to make maintenance checks of the Monitoring Panel except:

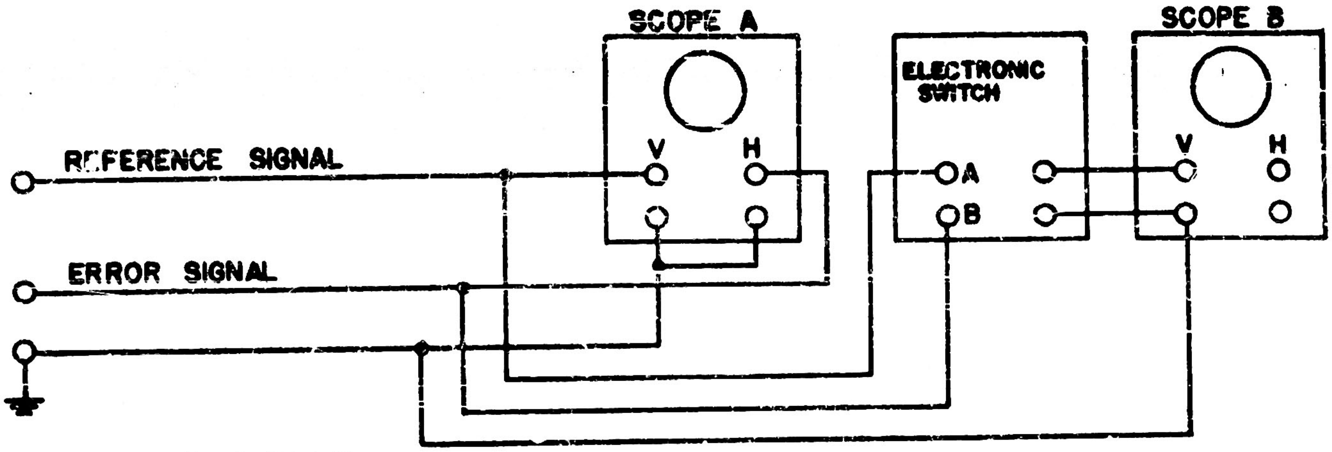
1. a 115 V, 60 cps power supply.
2. a wide range signal generator.
3. a stop watch.
4. a volt-ohm-milliameter (multimeter).

25. If the driving motor of the Monitoring Panel Graham Drive should fail during a dynamic Roll Sensitivity test, the output of the Sine Potentiometer would be:

1. zero volts.
2. 60 cps constant amplitude sine wave.
3. 400 cps constant amplitude sine wave.
4. a constant amplitude D.C. voltage, or zero volts.

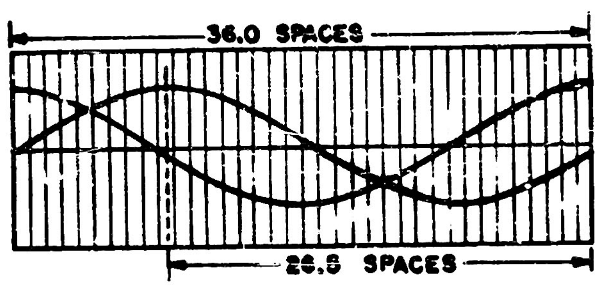
26. When running a missile system test using the Monitoring Panel, the External Missile Power switch is turned ON to start the warm up period. As this switch is thrown, the 60 cps and 400 cps lights go on. When warm up is completed, the warm up light goes on. The warm up light indicates that:

1. the missile power supply has reached operating temperature.
2. the regulated supply voltages have been stabilized.
3. a two minute period has been completed.
4. the guidance package amplifiers have been stabilized.

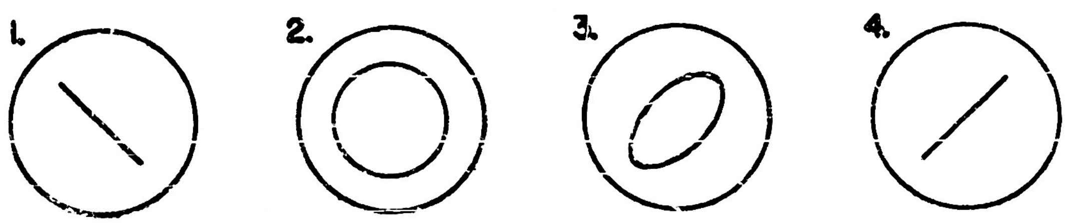



TEST SET-UP

27. The test signals from the Monitoring Panel 30 cps signal generators are to be checked by the test set-up shown in the diagram above. With the "Missile Position in Beam" Switch on "UP", Scope B shows the following traces




The trace seen on scope A will be:



28. To produce low frequency sine wave test signals for injection into the missile, the Monitoring Panel Sine Wave Chassis uses the following: a Graham Drive, a sine wave potentiometer, a synchro generator and a signal source.

Select the answer which describes the operation of these components.

| | The Graham Drive Rotates at: | The Sine Wave Potentiometer is energized by: | The Synchro Generator is energized by: |
|---|---|---|---|
| 1. | a speed which is a sine wave function of time. | a constant amplitude D.C. voltage. | 400 cps A.C. |
| 2. | A constant speed (predetermined by the operator). | a low frequency A.C. signal (frequency predetermined by the operator). | a low frequency A.C. signal (frequency predetermined by the operator. |
| 3. | a speed which is a sine wave function of time. | 110 volts A.C. | 110 volts A.C. |
| 4. | a constant speed (predetermined by the operator). | a constant amplitude D.C. voltage. | 400 cps A.C. |

FLIGHT READY INDICATOR

29. In setting up a Flight Ready Indicator missile test, the external air supply connection is not made. During the Flight Ready Indicator test the missile will shut down because:

1. no power will be applied during the warm up interval.
2. no power will be available after the two minute warm up light goes out.
3. no power will be available to close the power changeover relay.
4. no power will be available after the power changeover switch closes.

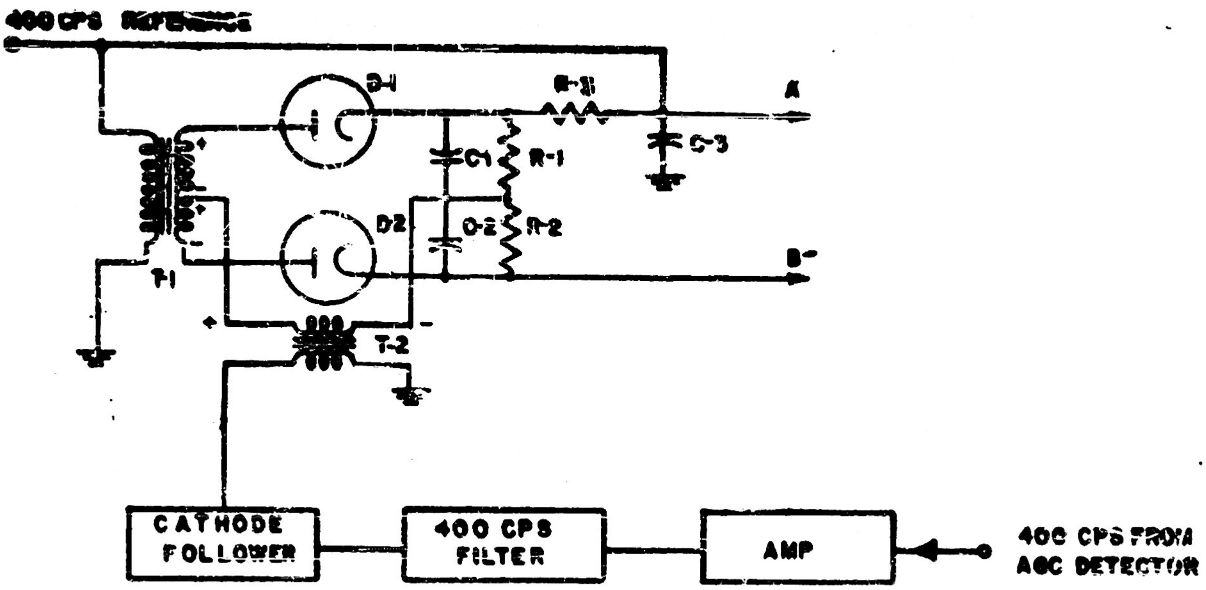
30. During a test of a missile using the Flight Ready Indicator the inputs to the Channel A and Channel B meters are determined by which of the following:

1. wing positions.
2. potentiometer slide positions.
3. rate of wing movement.
4. servo valve positions.

31. A two minute testing time limit is necessary when checking a missile with the Flight Ready Indicator. The reason for this time limit is to prevent:

1. overheating the FRI error amplifier.
2. depleting the air storage bottle contents.
3. overheating the alternator.
4. excess wear on the missile gyro.

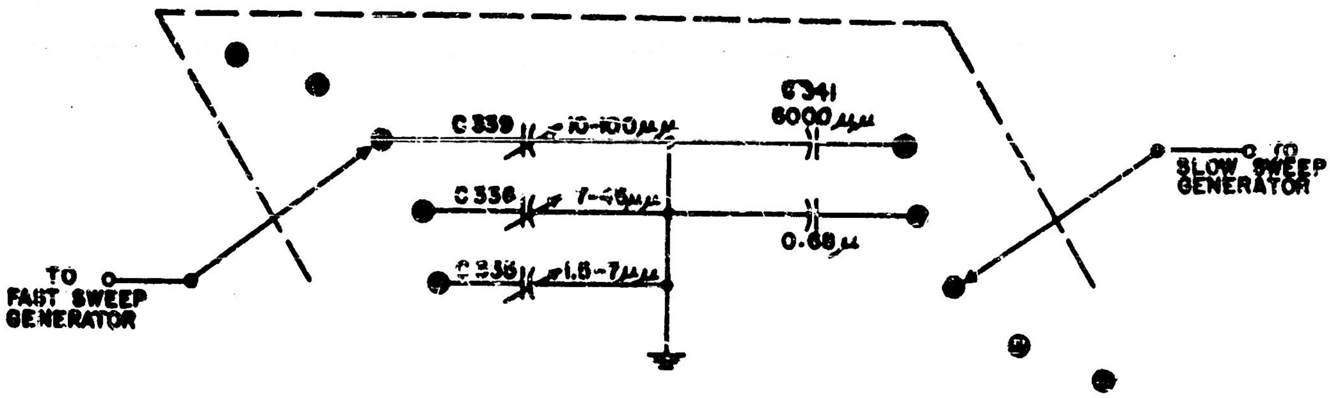
# GUIDANCE ANALYZER




SIMPLIFIED DIAGRAM PHASE COMPARATOR

32. The diagram shown above is similar to the 400 cycle phase comparator in the Guidance Analyzer. With the signal from the 400 cps filter in phase with the 400 cps reference voltage, the polarities are as shown on the transformer. Under this condition, which one of the following statements is correct?

1. Point A is positive with respect to ground.
2. Point A is negative with respect to the B minus bus.
3. Point A is positive with respect to the B minus bus.
4. Point A is at the same potential as the B minus bus.




33. The Guidance Analyzer sweep selector circuit is shown above. Which one of the following condensers is used to adjust the sweep speed to 5 microseconds per inch?

1. C-335
2. C-336
3. C-339
4. C-341

34. The phase calibration of the Guidance Analyzer does not accomplish which of the following?

1. Equalization of phase shifts in error and reference channels of the receiver.
2. Adjustment of phase splitter in the comparator chassis for proper $90^{\circ}$ phase splitting.
3. Proper adjustment of lead and lag potentiometers on the comparator chassis.
4. Compensation for the phase shift in the phase comparators on the comparator chassis.

APPENDIX B

THE TROUBLE-SHOOTING FORMBOARD ITEMS

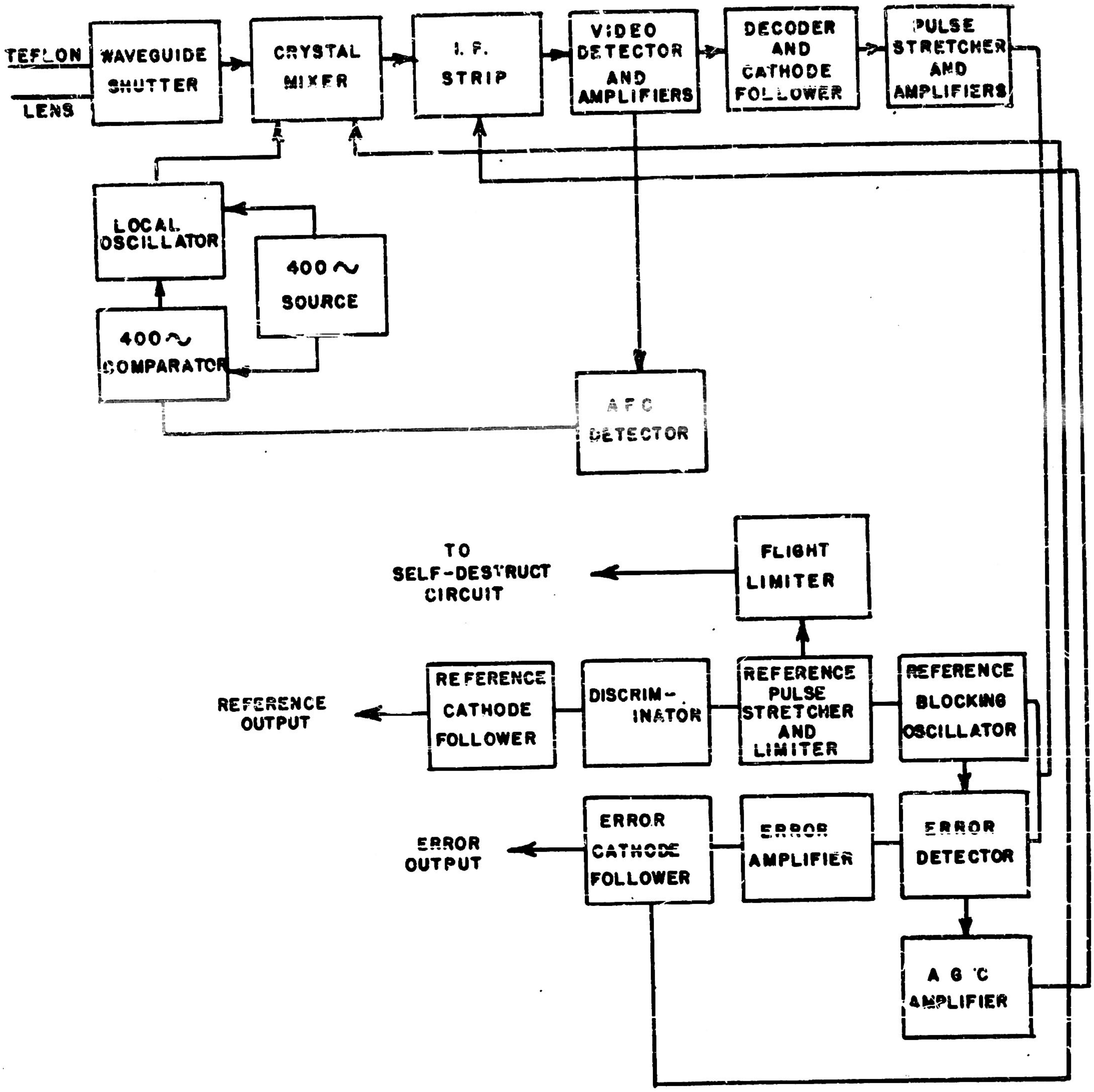
Formboard Item No. 1

S Y M P T O M

During a Monitoring Panel check on a TERRIER Receiver, the Beam Simulator is set for 12db error signal and -15 dbm range.

The Receiver output is measured and results obtained are as follows:

| | Measured Value | Normal Value |
|---|---|---|
| 30cps reference voltage | 0.0 V | 1 to 1.4 V |
| 30cps error voltage | 5.1 V | 4.3 to 5.3 V |




SUPERHET RECEIVER BLOCK DIAGRAM

## CHECKS

A) D.C. Voltage Checks

| | |
|---|---|
| Output of +200 Volt power supply | +200.1 volts |
| Output of -200 Volt power supply | -200.0 volts |
| Difference Voltage | +0.1 volts |

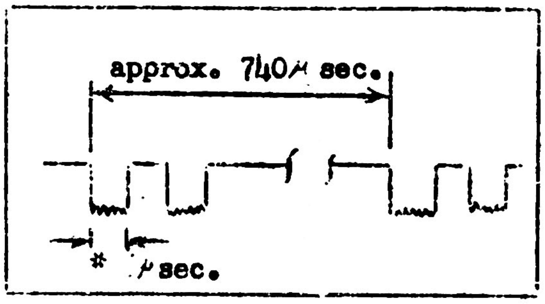
B) Crystal Mixer Current

Normal

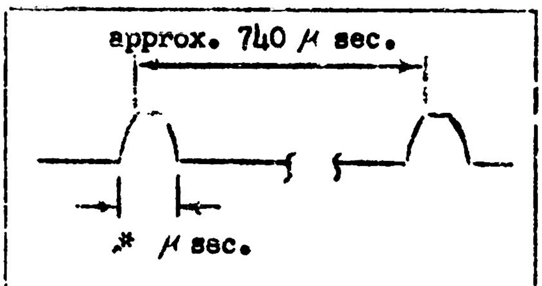
C) Wave Forms as Checked with an Oscillo-synchroscope

Beam Simulator set at 12db error -15dbm range.

1. Video Detector Output

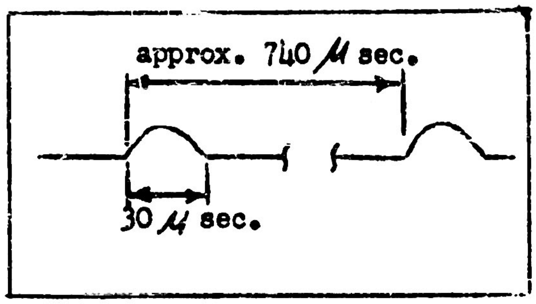



2. Decoder Output

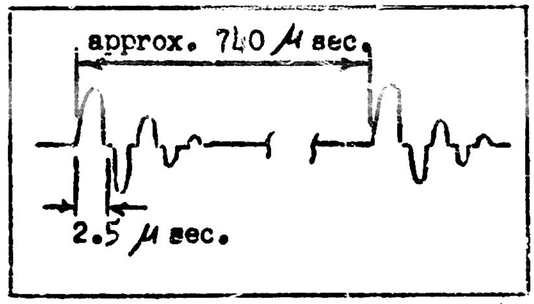



* Normal pulse width; exact value omitted in this report.

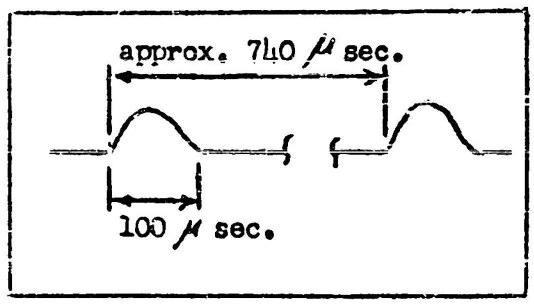
3. Pulse Stretcher Output



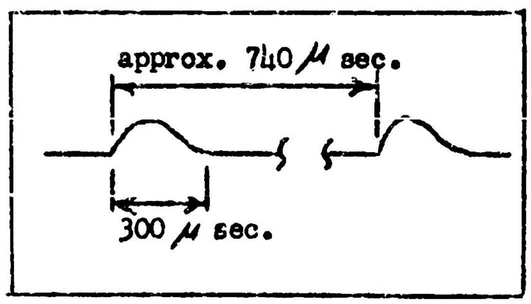

4. Reference Blocking Oscillator Output




5. Output of Error Pulse Stretcher




6. Output of Reference Limiter



7. Output of Reference Discriminator

No Output

8. Output of Reference Cathode Follower

No Output

9. Output of Error Detector

30 cps

10. Output of Error Amplifier

30 cps

D) <u>Local Oscillator Output</u>

Checked with a Microwave Power Meter.

1 milliwatt output (normal)

E) AFC Operation

Observe Reflector Voltage as Klystron tuner is moved slightly.

| |
|---|
| Reflector voltage varies |

F) AGC Operation

Input wave from Beam Simulator increased.
Voltage on I.F. grids noted.

| |
|---|
| I.F. grids go more negative. |

## UNITS

| | | | |
|---|---|---|---|
| 1. Local Oscillator | NO | 11. Error Pulse Stretcher | NO |
| 2. Crystal Mixer | NO | 12. Error Detector | NO |
| 3. I.F. | NO | 13. Error Amplifier | NO |
| 4. Video Detector | NO | 14. AGC | NO |
| 5. Decoder | NO | 15. AFC | NO |
| 6. Pulse Stretcher | NO | 16. Wave guide Shutter | NO |
| 7. Reference Blocking Oscillator | NO | | |
| 8. Reference Pulse Stretcher | NO | | |
| 9. Reference Discriminator | YES | | |
| 10. Reference Cathode Follower | NO | | |

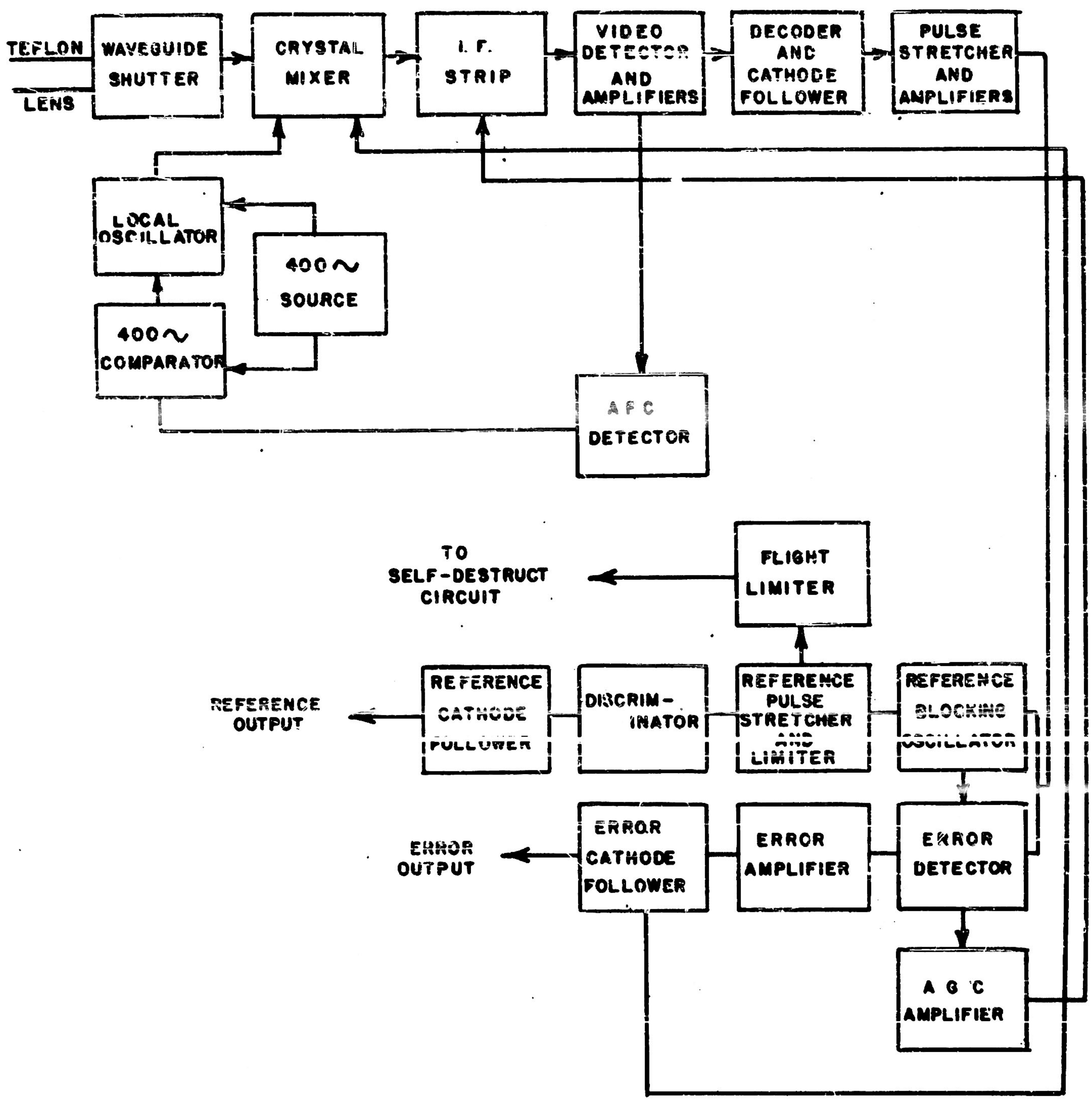
Formboard Item No. 2

## SYMPTOM

During a Monitoring Panel check on a TERRIER Receiver, the Beam Simulator is set for 12db error signal and -15dbm range.

The Receiver output is measured and results obtained are as follows:

| | Measured Value | Normal Value |
|---|---|---|
| 30cps reference voltage | 1.2 V | 1 to 1.4 V |
| 30cps error voltage | 7.2 V | 4.3 to 5.3 V |




SUPERHET RECEIVER BLOCK DIAGRAM

## CHECKS

A) D.C. Voltage Checks

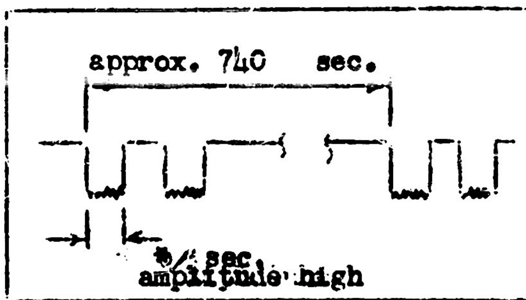
| | |
|---|---|
| Output of +200 volts Powerr Supply | +200.0 |
| Output of -200 volts Power Supply | -199.8 |
| Difference Voltage | +0.2 |

B) Crystal Mixer Current — Normal

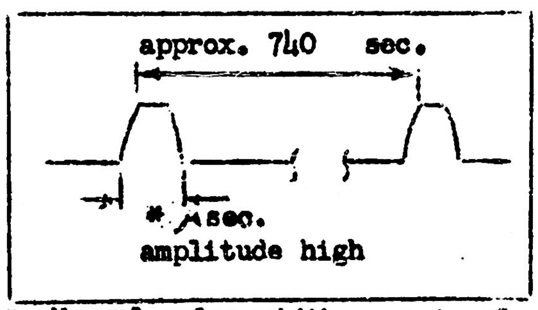
C) Wave Forms as Checked with an Oscillo-synchroscope

Beam Simulator set at 12db error -15dbm range.

1. Video Detector Output

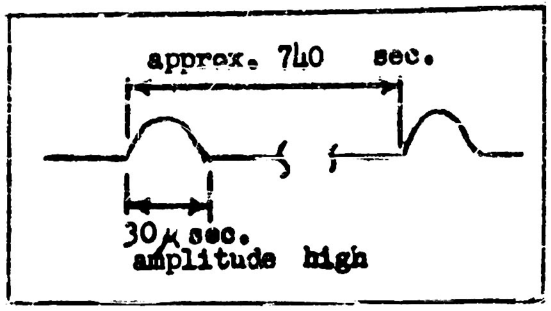



2. Decoder Output

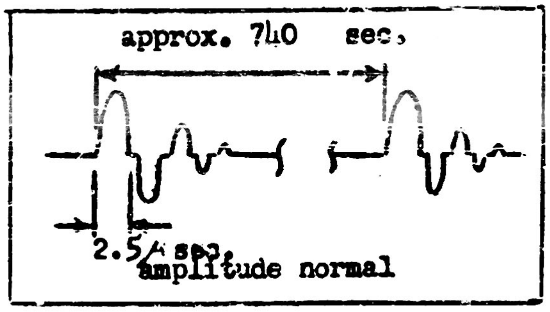



* Normal pulse width; exact value omitted in this report.

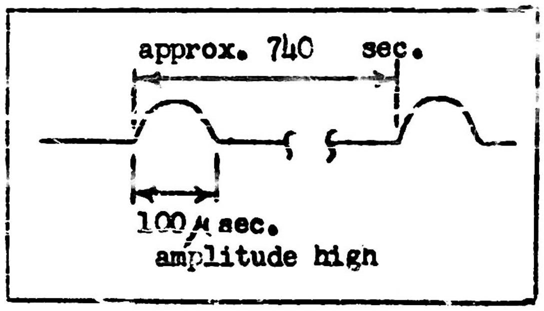
3. Pulse Stretcher Output



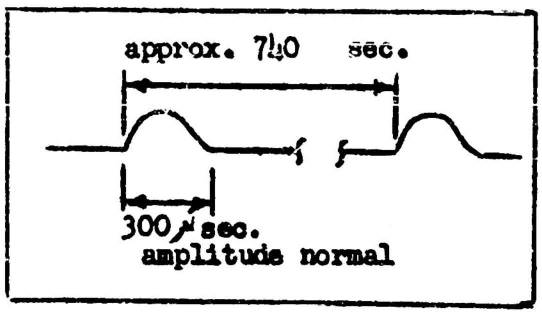

4. Reference Blocking Oscillator Output



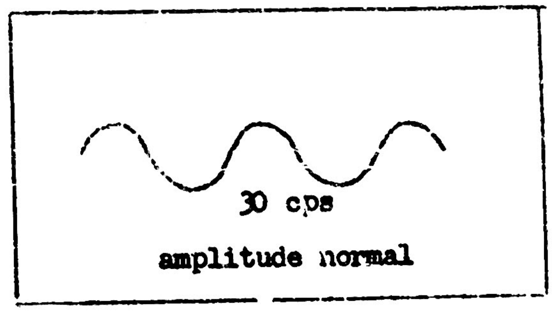

5. Output of Error Pulse Stretcher



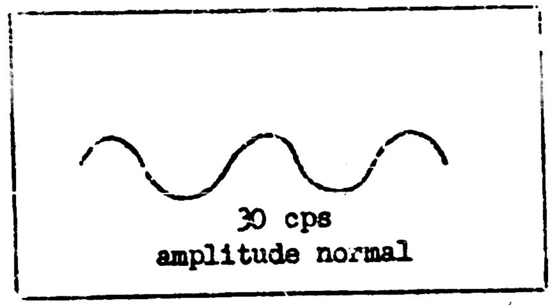

6. Output of Reference Limiter



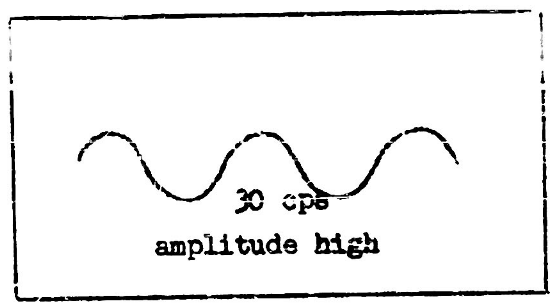
7. Output of Reference Discriminator



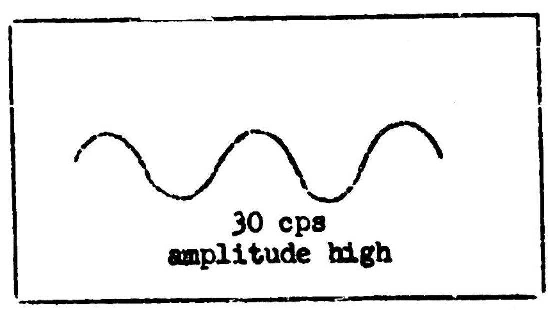

8. Output of Reference Cathode Follower




9. Output of Error Detector




10. Output of Error Amplifier



| | |
|---|---|
| D) **Local Oscillator Output**<br>Checked with a Microwave Power Meter. | 1 microwatt (normal) |
| E) **AFC Operation**<br>Observe Reflector Voltage as Klystron tuner is moved slightly. | reflector voltage varies |
| F) **AGC Operation**<br>Input wave from Beam Simulator increased.<br>Voltage on I.F. grids noted. | no change |

## UNITS

| | | |
|---|---|---|
| 1. | Local Oscillator | NO |
| 2. | I.F. | NO |
| 3. | Video Detector | NO |
| 4. | Decoder | NO |
| 5. | Pulse Stretcher | NO |
| 6. | Reference Blocking Oscillator | NO |
| 7. | Reference Pulse Stretcher | NO |
| 8. | Reference Discriminator | NO |
| 9. | Reference Cathode Follower | NO |
| 10. | Error Pulse Stretcher | NO |
| 11. | Error Detector | NO |
| 12. | Error Amplifier | NO |
| 13. | AGC | YES |
| 14. | AFC | NO |
| 15. | Waveguide Shutter | NO |

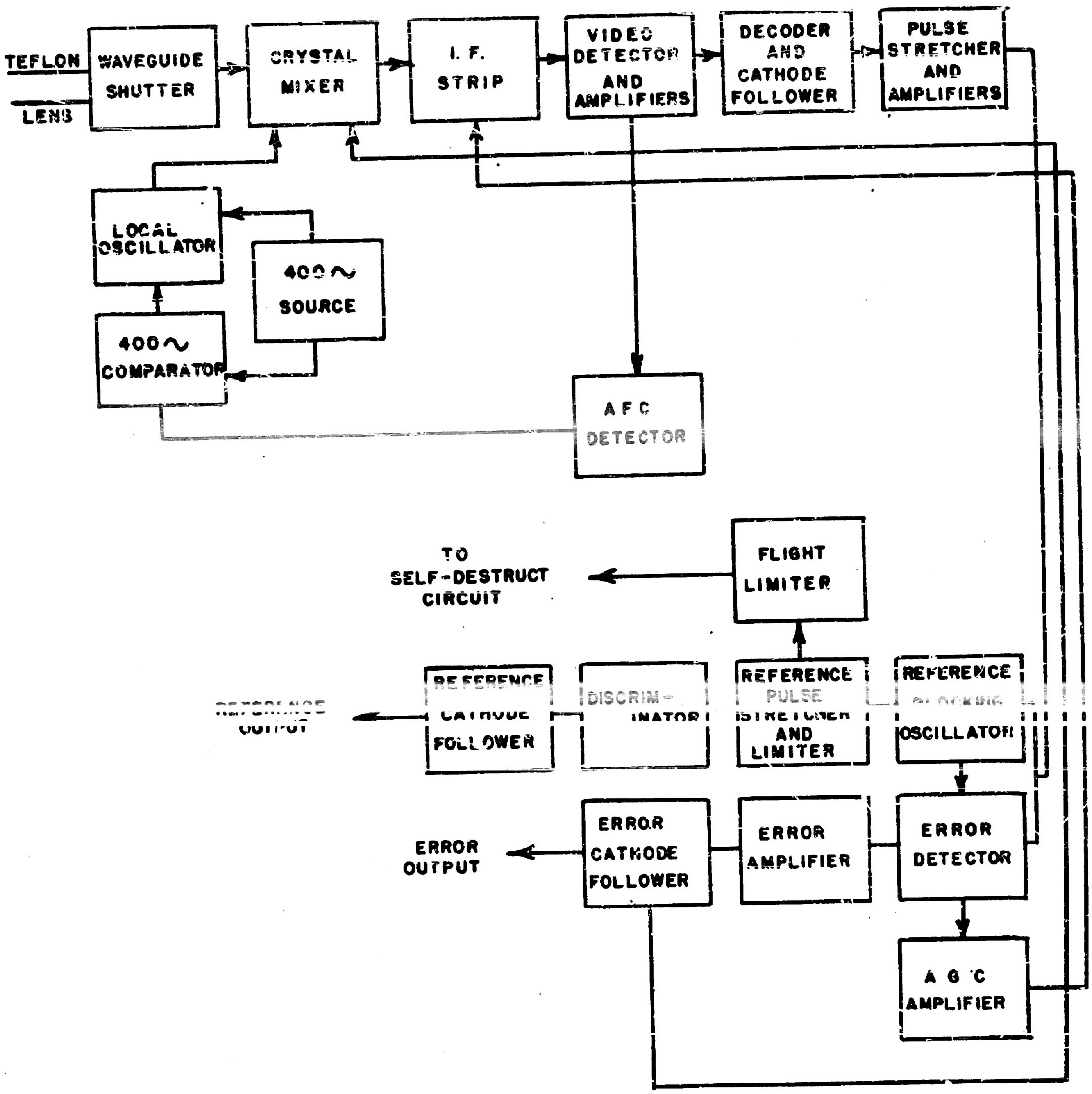
Formboard Item No. 3

## SYMPTOM

During a Monitoring Panel check on a TERRIER Receiver, the Beam Simulator is set for 12db error signal and -15dbm range.

The Receiver output is measured and results obtained are as follows:

| | Measured Value | Normal Value |
|---|---|---|
| 30cps reference voltage | 0.0 V | 1 to 1.4 V |
| 30cps error voltage | 0.0 V | 4.3 to 5.3 V |




SUPERHET RECEIVER BLOCK DIAGRAM

## CHECKS

| | |
|---|---|
| 1. D.C. Voltage Checks<br>Output of +200 Volt Power Supply<br>Output of -200 Volt Power Supply<br>Difference Voltage | All normal |
| 2. Crystal Mixer Current | Zero |
| 3. Wave Forms as Checked with an Oscillo-synchroscope<br>Beam Simulator set at 12db error 15dbm range. | |
| a. Video Detector Output | Zero |
| b. Decoder Output | Zero |
| c. Pulse Stretcher Output | Zero |

| | |
|---|---|
| d. Reference Blocking Oscillator Output | Zero |
| e. Output of Error Pulse Stretcher | Zero |
| f. Output of Reference Limiter | Zero |
| g. Output of Reference Discriminator | Zero |
| h. Output of Reference Cathode Follower | Zero |
| i. Output of Error Detector | Zero |

| | |
|---|---|
| j. Output of Error Amplifier | Zero |
| 4. **Local Oscillator**<br>Check output with microwave power meter. | 1 milliwatt (normal) |
| 5. **AFC Operation**<br>Observe reflector voltage as klystron tuner is moved slightly. | No change in reflector voltage |
| 6. **AGC Operation**<br>Increase power from Beam Simulator.<br>Check IF grid voltages. | No change |

UNITS

| | | | |
|---|---|---|---|
| 1. Local Oscillator | NO | 13. Error Amplifier | NO |
| 2. Crystal Mixer | YES | 14. AGC | NO |
| 3. I.F. | NO | 15. AFC | NO |
| 4. Video Detector | NO | 16. Waveguide Shutter | NO |
| 5. Decoder | NO | | |
| 6. Pulse Stretcher | NO | | |
| 7. Reference Blocking Oscillator | NO | | |
| 8. Reference Pulse Stretcher | NO | | |
| 9. Reference Discriminator | NO | | |
| 10. Reference Cathode Follower | NO | | |
| 11. Error Pulse Stretcher | NO | | |
| 12. Error Detector | NO | | |

Formboard Item No. 4

SYMPTOM

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up completed OK | GREEN | GREEN | GREEN |
| B | Unit did not shut down | GREEN | GREEN | GREEN |
| C | Meter 1 and 2 inoperative in this position | - | - | GREEN |
| D | Meter 3 goes to Zero after 40 sec. | GREEN | GREEN | GREEN |
| E | | RED | RED | GREEN |
| F | | RED | RED | GREEN |
| G | | GREEN | GREEN | GREEN |

OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |
| FLIGHT READY INDICATOR | | | |

## CHECKS

A) The following checks make use of the Monitoring Panel.

1. **Regulated Power Supply Output Voltages using external power**

   -200 volts: normal
   +200 volts: normal
   Difference Volts: normal

2. **Primary Internal Power and Low Voltage Supply Output using External air**

   Time for power change-over: normal
   Alternator phasing: normal
   Low voltage supply volts: normal
   400cps frequency: normal
   Alternator voltage: normal

3. **Hydraulic Pressure**

   Turn on External air switch.
   Read hydraulic pressure on gauge connected into high pressure side of hydraulic sump.

   Pressure 1300psi (normal)

4. **Destruct Time**

   2.6 sec. (normal)

5. Receiver Output

Beam Simulator used to supply signal to missile waveguide input.
Measure 30cps reference and error signals at Receiver output.

30cps reference: normal
30cps error: normal

6. Intelligence Converter Alignment

Signal from Monitoring Panel to intelligence converter input.
Change phasing control to all positions.
Adjust phasing pots for minimum computer monitor output voltage.
Record minimum and maximum.

Zero volts minimum
Zero volts maximum

7. Wing Speed

D.C. step signal to input of A and B channel servo amplifiers.
Record wing positions and compute wing speeds.

Wing speeds
A wing, 50°/sec. (normal)
B wing, 50°/sec. (normal)

8. Computer and Servo Sensitivity

30cps reference and error signals fed from Monitoring Panel to input intelligence converter.
Adjust input signal magnitude to give computer monitor output of 6.0V.
Read wing positions on wing protractors.

Both A and B channel computer monitor voltages are Zero volts and cannot be adjusted.
No motion of A or B wings

| | |
|---|---|
| 9. Rolleron Speed<br>D.C. step signal to input roll servo amplifier. Record rolleron positions and compute rolleron speed. | Rolleron speed $200^{\circ}$/sec. (normal) |
| 10. Roll Sensitivity and Balance | All rolleron positions normal |
| B) Check Beam Simulator output with oscilloscope | Output normal |

UNITS

| | | | | | |
|---|---|---|---|---|---|
| 1. | Regulated power supply package | NO | 7. | A and B wing hydraulic actuators | NO |
| 2. | Beam Simulator | NO | 8. | A and B wing hydraulic valves | NO |
| 3. | Autopak | NO | 9. | Receiver package | NO |
| 4. | Waveguide shutter mechanism | NO | 10. | Alternator | NO |
| 5. | Hydraulic motor | NO | 11. | Hydraulic sump | NO |
| 6. | Guidance package | YES | | | |

Formboard Item No. 5

SYMPTOM

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up completed | GREEN | GREEN | GREEN |
| B | Unit does not shut down | GREEN | GREEN | GREEN |
| C | Meter 1 and 2 inoperative in this position | - | - | GREEN |
| D | Meter 3 goes to Zero after 40 sec. | GREEN | GREEN | GREEN |
| E | | GREEN | RED | GREEN |
| F | | GREEN | RED | GREEN |
| G | | GREEN | GREEN | GREEN |
| OFF | Gyro cages | | | |

OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |
| FLIGHT READY INDICATOR | | | |

## CHECKS

A) The following checks make use of the Monitoring Panel.

1. **Regulated Power Supply Output Voltages**

   External power used.

   | |
   |---|
   | All normal |

2. **Primary Internal Power and Low Voltage Supply Output**

   Turn external air on.
   Compute power changeover time.
   Record alternator voltage.
   Record alternator frequency.
   Check alternator phasing.
   Record +30 V output.

   | |
   |---|
   | Power changeover time: normal<br>Alternator voltage: normal<br>Alternator frequency: normal<br>Alternator phasing: normal<br>+30 V output: normal |

3. **Hydraulic Check**

   Turn external air on.
   Read hydraulic pressure on gauge connected into high pressure side of hydraulic sump.

   | |
   |---|
   | Sump pressure: normal |

4. **Receiver Output**

   Signal from Beam Simulator fed to missile waveguide input.
   Error and Reference signal outputs from receiver observed.

   | |
   |---|
   | Error and Reference signals: normal |

5. Intelligence Converter "A" Channel Phasing Adjustment

Turn external power on.
Signal from Beam Simulator: 4db error, -30dbm range.
Adjust phase of signal to all positions in turn.
Adjust phasing pot for minimum computer monitor output.

| |
|---|
| Adjustment gives normal minimum reading |

6. Intelligence Converter "B" Channel Phasing Adjustment

Turn external power on.
Signal from Beam Simulator: 4db error, -30dbm range.
Adjust phase of signal to all positions in turn.
Adjust phasing pot for minimum computer monitor output.

| |
|---|
| Computor monitor voltage: Zero V. No adjustment possible |

7. Intelligence Converter "A" Channel Sensitivity and Phasing

Turn external power on.
Signal from Beam Simulator: 2db error -15 and -30dbm range; phasing DOWN.
Read "A" channel computer monitor voltage.

| |
|---|
| Computer monitor output: normal. |

8. Intelligence Converter "B" Channel Sensitivity and Phasing

Turn external power on.
Signal from Beam Simulator: 2db error, -15 and -30dbm range; phasing DOWN.
Read "B" channel computer monitor voltage.

| |
|---|
| Computer monitor output: Zero V. |

9. "A" Wing Trim Adjustment

Turn external air on.
Ground servo amplifier grid and adjust trim pots for Zero degrees wing position.

| |
|---|
| Adjustment made normally |

10. "B" Wing Trim Adjustment

Turn external air on.
Ground servo amplifier grid and adjust trim pots for Zero degrees wing position.

| |
|---|
| Adjustment made normally |

11. "A" Wing Speed Check

Turn on external air.
Apply -2.5 volt step signal to input servo amplifier.
Take a Brush recording of wing action.
Compute wing speed from record.

| |
|---|
| Wing speed: normal |

12. "B" Wing Speed Check

Turn on external air.
Apply -2.5 volt step signal to input servo amplifier.
Take a Brush recording of wing action.
Compute wing speed from record.

| |
|---|
| Wing speed: normal |

13. "A" Channel Computer and Servo Sensitivity

Turn on external air.
Apply 30cps error and reference signals to input of Intelligence Converter, phased DOWN and UP in order.
Read wing positions for specified timer, computer monitor and altitude settings.

| |
|---|
| All readings normal |

14. "B" Channel Computer and Servo Sensitivity

Turn on external air.
Apply 30cps error and reference signals to input of Intelligence Converter, phased DOWN and UP in order.
Read wing positions for specified timer, computer monitor and altitude settings.

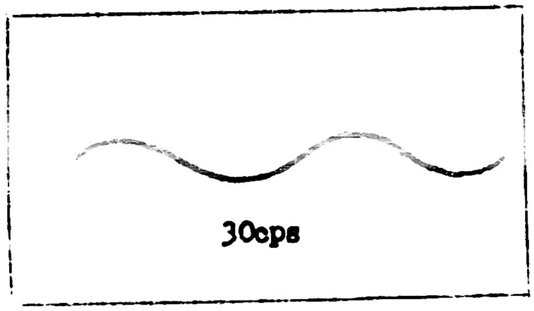
| |
|---|
| No wing motion |

| | |
|---|---|
| 15. **"A" Channel Dynamic Guidance Sensitivity**<br>Turn on external air switch.<br>Apply 30cps error signal to input of Intelligence Converter; vary signal at 0.5cps sine rate. | Normal recording |
| 16. **"B" Channel Dynamic Guidance Sensitivity**<br>Turn on external air switch.<br>Apply 30cps error signal to input of Intelligence Converter; vary signal at 0.5cps sine rate. | No wing motion |
| 17. **"A" Channel Integral Response Check**<br>Turn on external air switch.<br>Apply 30cps reference and error signals to input of intelligence converter, phase UP, then DOWN.<br>For each phase, take wing position reading with integrator grounded, then with integrator ungrounded. | All readings normal |
| 18. **"B" Channel Integral Response Check**<br>Turn on external air switch.<br>Apply 30cps reference and error signals to input of intelligence converter, phase UP, then DOWN,<br>For each phase, take wing position reading with integrator grounded, then with integrator ungrounded. | No wing motion |

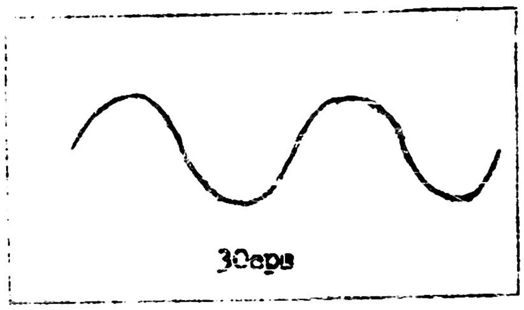
B) <u>Waveform Checks</u>

Turn on external power.
Signal from Beam Simulator
to missile waveguide input;
2db error, -30dbm range;
phase DOWN.
Set timer to 10 sec.
Observe the following waveforms.

1. Error signal output from Receiver.




2. Reference signal output from Receiver.




3. Output from error driver.

Normal

4. Output from "A" channel section of phase splitter.

Normal

| | |
|---|---|
| 5. Output from "B" channel section of phase splitter. | Normal |
| 6. Output from "A" channel reference driver. | Normal |
| 7. Output from "B" channel reference driver. | No signal |
| 8. Output from "A" channel phase comparator. | Normal |
| 9. Output from "B" channel phase comparator. | No signal |
| 10. Input to "A" Channel compensated D.C. amplifiers | Normal |

| | |
|---|---|
| 11. Input to "B" Channel compensated D.C. amplifiers. | No signal |
| 12. Input to "A" Channel integrating amplifiers. | Normal |
| 13. Input to "B" Channel inegrating amplifiers. | No signal |
| 14. Input to "A" Channel inverse pressure pot. | Normal |
| 15. Input to "B" Channel inverse pressure pot. | No signal |
| 16. Input to "A" Channel Servo amplifier. | Normal |

| | |
|---|---|
| 17. Input to "B" Channel Servo amplifier. | No signal |
| 18. Input to "A" Channel Servo hydraulic valves. | Normal |
| 19. Input to "B" Channel Servo hydraulic valves. | No signal |

## UNITS

| | | | | | |
|---|---|---|---|---|---|
| 1. | Receiver | NO | 11. | "B" Channel Reference Driver | YES |
| 2. | Primary Power Supply | NO | 12. | 1st Computer Amplifier "A" Channel | NO |
| 3. | Regulated D.C. Power Supply | NO | 13. | 1st Computer Amplifier "B" Channel | NO |
| 4. | Unregulated D.C. Power Supply | NO | 14. | Computer Gain Change Network "A" Channel | NO |
| 5. | Phase splitter | NO | 15. | Computer Gain Change Network "B" Channel | NO |
| 6. | "A" Channel Phase Comparator | NO | 16. | First Limiter (A and B Channel) | NO |
| 7. | "B" Channel Phase Comparator | NO | 17. | Integrating Amplifier "A" Channel | NO |
| 8. | "A" Channel Rate Network | NO | 18. | Integrating Amplifier "B" Channel | NO |
| 9. | "B" Channel Rate Network | NO | 19. | Integral Limiter ("A" and "B" Channel) | NO |
| 10. | "A" Channel Reference Driver | NO | 20. | Fixed Limiter ("A" and "B" Channel) | NO |

| | | | | | |
|---|---|---|---|---|---|
| 21. | Cathode Follower "A" Channel | NO | 26. | Hydraulic Valves "B" Channel | NO |
| 22. | Cathode Follower "B" Channel | NO | 27. | Autopak | NO |
| 23. | Servo Amplifier "A" Channel | NO | 28. | Hydraulic Actuator "A" Wing | NO |
| 24. | Servo Amplifier "B" Channel | NO | 29. | Hydraulic Actuator "B" Wing | NO |
| 25. | Hydraulic Valves "A" Channel | NO | 30. | Programmer | NO |

Formboard Item No. 6

SYMPTOM

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up completed OK | GREEN | GREEN | GREEN |
| B | Unit did not shut down | GREEN | GREEN | GREEN |
| C | Meter 1 and 2 inoperative in this position | - | - | GREEN |
| D | Meter 3 goes to Zero after 40 sec. | RED | RED | GREEN |
| E | | RED | RED | GREEN |
| F | | RED | RED | GREEN |
| G | | RED | RED | GREEN |
| OFF | Gyro cages | | | |

## OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |

FLIGHT READY INDICATOR

## CHECKS

The following checks make use of the Monitoring Panel.

| | |
|---|---|
| A) **Regulated Power Supply Output**<br>External power used. | Normal |
| B) **Sustainer Voltage** | Normal |
| C) **Primary Internal Power and Low Voltage**<br>External air used. | Primary voltage and frequency: normal<br>Low voltage: normal |
| D) **Hydraulic Pressure**<br>Read hydraulic pressure on gauge connected to high pressure side of hydraulic sump. | Normal |
| E) **Receiver Output**<br>Signal from Beam Simulator fed to missile waveguide input.<br>Error and reference outputs from receiver observed. | 30cps reference and error: normal |

F) Intelligence Converter Alignment

Signal from Beam Simulator: 4db error, -30dbm range.
Adjust phase of signal to all positions in turn.
Adjust phasing pots for minimum voltage from computer monitor.

| |
|---|
| Adjustment made normally |

G) Intelligence Converter Sensitivity and Phasing

1. Signal from Beam Simulator: 4db error, -30dbm range.
   Adjust timer to end of flight.
   Change error signal to all phase positions.
   Read Computer Monitor voltage.

| |
|---|
| Normal |

2. Signal from Beam Simulator: 2db error, -15dbm range.
   Adjust timer to 3 secs.
   Change error signal to all phase positions.
   Read Computer Monitor voltage.

| |
|---|
| Normal |

3. Signal from Beam Simulator: 2db error, -30dbm range.
   Adjust timer to end-of-flight position; phasing DOWN.
   Read Computer Monitor voltage.

| |
|---|
| Normal |

H) Wing Trim Adjustment

Turn on External air.
Set altitude switch to 20,000 ft.
Ground grid of servo amplifiers at VTVM.
Adjust trim pots for Zero degree wing positions.

| |
|---|
| Both "A" and "B" wings can be adjusted to Zero degrees. |

I) Wing Speed Check

Apply 2.5 volts D.C. step signal to input servo amplifiers.
Record wing position and compute maximum wing speed.

| |
|---|
| Wing speed normal for both wings |

J) Computer and Servo Sensitivity

Signal from Monitoring Panel: 30cps reference and error signals to input intelligence converter.

1. Set timer to 3 sec.
   Set altitude switch to SEA LEVEL.
   Adjust input signal to give computer monitor output of 6.0V phase UP and DOWN in order.
   Read wing angles.

| |
|---|
| Positions of A and B wings:<br>Phase UP: -11° (normal -6°)<br>Phase DOWN: -5° (normal +6°)<br>A and B wings both deflect to -11° before error and reference signals applied. |

2. Set timer to 10 sec.
   Set altitude switch to SEA LEVEL.
   Adjust input signal to give computer monitor output of 20 V.
   Read wing angles.

> Positions of A and B wings
> Phase UP: $-1\ 1/2^\circ$ (normal $-3^\circ$)
> Phase DOWN: $+1\ 1/2^\circ$ (normal $+3^\circ$)
> A and B wings both deflect to $-1\ 1/2^\circ$ before error and reference signals applied.

3. Set timer to 22 sec.
   Set altitude switch SEA LEVEL.
   Adjust input signal to give computer monitor output of 20V.
   Read wing angles.

> Positions of A and B wings
> Phase UP: $-3^\circ$ (normal $-6^\circ$)
> Phase DOWN: $+3^\circ$ (normal $+6^\circ$)
> A and B wings both deflect to $-3^\circ$ before error and reference signals applied.

4. Set timer to 22 sec.
   Set altitude switch to 20,000 ft.
   Adjust input signal to give computer monitor output of 20V.
   Read wing angles.

> Positions of A and B wings
> Phase UP: $-7^\circ$ (normal $-14^\circ$)
> Phase DOWN: $+7^\circ$ (normal $+14^\circ$)
> A and B wings both deflect to $-7^\circ$ before error and reference signals applied.

5. Set Intercept switch to 10 sec.
   Set timer to 22 sec.
   Set altitude switch to SEA LEVEL.
   Adjust input signal to give computer monitor output of 20V.
   Read wing angles.

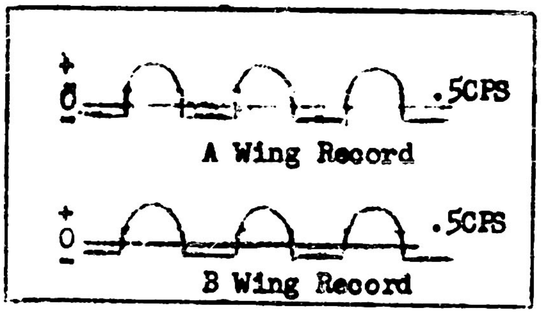
> Positions of A and B wings
> Phase UP: $-4^\circ$ (normal $-6^\circ$)
> Phase DOWN: $+4^\circ$ (normal $+8^\circ$)
> A and B wings both deflect to $-4^\circ$ before error and reference signals applied.

6. Set intercept switch to 10 sec.
Set timer to 22 sec.
Set altitude switch to SEA LEVEL.
Unground integrator.
Adjust input signal to give computer monitor output of 20V.
Read wing angles.

Position of A and B wings
Phase UP: $-15^\circ$ (normal $-15^\circ$)
Phase DOWN: $+15^\circ$ (normal $+15^\circ$)
A and B wings both deflect to $-15^\circ$ before error and reference signals applied.

K) <u>Dynamic Guidance Sensitivity</u>

Ground integrator.
Set timer to 22 sec.
Set altitude SEA LEVEL.
Adjust Graham drive for speed of 0.5cps.
Adjust 30cps error signal to input of intelligence converter to give 2.0 volts peak-to-peak computer monitor voltage.
Record wing positions.




L) <u>Integral Response Check</u>

Set timer to end-of-flight.
Apply 30cps reference and error signals to input intelligence converter.

1. Phase error signal DOWN and adjust signal for computer monitor output of 2.0V.
Read wing position with integrator grounded.
Start Brush recording of wing position.
Read wing position with integrator ungrounded.
Compute average rate of wing movement.
Repeat for other channel.

Positions of A and B wings:
Integrator grounded $-5^\circ$ (normal $+1\ 1/2^\circ$)
Integrator ungrounded: $-15^\circ$ (normal $+10^\circ$)
Rate = 4 times normal

2. Phase error signal UP and adjust signal for computer monitor output of 2.0V.
Read wing position with integrator grounded.
Start Brush recording of wing position.
Read wing position with integrator ungrounded.
Compute average rate of wing movement.
Repeat for other channel.

| |
|---|
| Positions of A and B wings: |
| Integrator grounded: -7° (normal: -1 1/2°) |
| Integrator ungrounded: -15° (normal: -10°) |
| Rate: 5 times normal rate. |

## UNITS

| | | | | | |
|---|---|---|---|---|---|
| 1. | Receiver | NO | 11. | 1st Computer Amplifier "B" Channel | NO |
| 2. | Primary Power Supply | NO | 12. | Computer Gain Change Network "A" Channel | NO |
| 3. | Regulated D.C. Power Supplies | NO | 13. | Computer Gain Change Network "B" Channel | NO |
| 4. | Phase Splitter | NO | 14. | First Limiter ("A" and "B" Channel) | YES |
| 5. | Intelligence Converter Error Amplifier | NO | 15. | Integrating Amplifier "A" Channel | NO |
| 6. | "A" Channel Phase Comparator | NO | 16. | Integrating Amplifier "B" Channel | NO |
| 7. | "B" Channel Phase Comparator | NO | 17. | Integral Limiter ("A" and "B" Channel) | NO |
| 8. | "A" Channel Rate Network | NO | 18. | Fixed Limiter ("A" and "B" Channel) | NO |
| 9. | "B" Channel Rate Network | NO | 19. | Cathode Follower "A" Channel | NO |
| 10. | 1st Computer Amplifier "A" Channel | NO | 20. | Cathode Follower "B" Channel | NO |

| | | | | | |
|---|---|---|---|---|---|
| 21. | Servo Amplifier "A" Channel | NO | 23. | Hydraulic System | NO |
| 22. | Servo Amplifier "B" Channel | NO | 24. | Programmer | NO |

Formboard Item No. 7

## SYMPTOM

FRI Check Sheet

| Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | | GREEN | GREEN | GREEN |
| B | Unit shuts down as switch thrown to B | - | - | - |

TEST DISCONTINUED

OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |
| FLIGHT READY INDICATOR | | | |

## CHECKS

A) **Missile Warm Up**

Turn on External Missile Power switch.
Check 60cps and 400cps lights.
After 2 minutes, check warm-up light.

| |
|---|
| 60cps light: ON |
| 400cps light: ON |
| Warm up light: ON |

B) **Actuate Missile Operate Relay Switch**

Check gyro caged light.
Check missile operate light.

| |
|---|
| Gyro caged light stays OFF. |
| Missile operate light goes ON. |

C) **Programmer Test**

Turn on Missile Operate switch.
Hold Timer Run switch on for approximately 45 sec.
After six sec., check Guidance Beam and Intercept lights.
After 40 sec., check Programmer meter.

| |
|---|
| Guidance Beam light: OFF |
| Intercept light: OFF |
| Programmer Meter: "end of run" |

D) **Programmer Reset Check**

Turn off Timer Run Switch.
Turn off Missile Operate switch.
Wait for Programmer Meter to go to Zero.
Check gyro caged light.

| |
|---|
| Programmer Meter: Zero sec. |
| Gyro caged light: OFF |

E) **Regulated Power Supply Check**

Turn on External power.
Read D.C. output voltages.

| |
|---|
| +200 Volts: normal |
| -200 Volts: normal |
| Difference Voltage: normal |

F) Primary Power and Low Voltage Supply Checks

Turn on External air switch.
Check power changeover time.
Check alternator phasing.
Check alternator frequency.
Check alternator voltage.
Check +30V D.C. output.

| |
|---|
| Power changeover time: normal<br>Phase lights: normal<br>Alternator frequency: normal<br>Alternator voltage: normal<br>+30 Volts: Zero volts |

G) Hydraulic Pressure Check

Turn on External air switch.
Read hydraulic pressure on gauge connected to high pressure side of hydraulic sump.

| |
|---|
| Pressure normal |

H) Receiver Output

12db error signal, -15dbm range from Beam Simulator to missile wave guide.
Read receiver Output Voltages.

| |
|---|
| 30cps reference normal<br>30cps error normal |

I) Destruct Time Check

12db error signal, -15dbm range from Beam Simulator to missile wave guide.
Turn Recorder Switch on Brush #2 to DESTRUCT Position.
Turn DESTRUCT Test switch to R.F. Off Position
Read DESTRUCT time from record.

| |
|---|
| Destruct time: normal |

UNITS

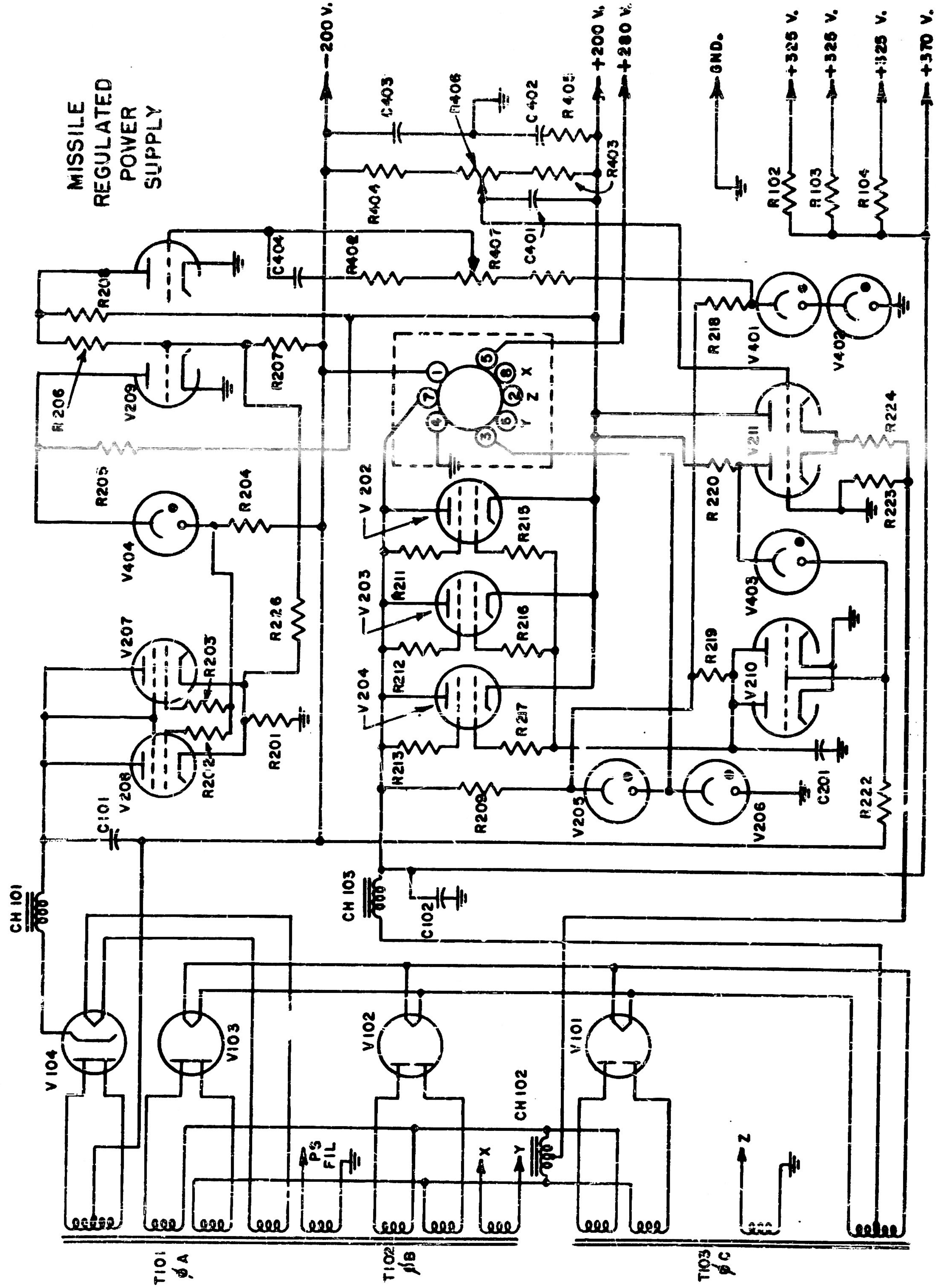
| | | | |
|---|---|---|---|
| 1. Alternator | NO | 7. Capacitor Bank | NO |
| 2. Power Supply Package | YES | 8. Air Shut-off Valve | NO |
| 3. Guidance Package | NO | 9. Power Changeover Relay | NO |
| 4. Backscratcher | NO | 10. Missile Operate Relay | NO |
| 5. Roll Free Gyro | NO | 11. Gyro Cage Motor Unit | NO |
| 6. Programmer | NO | 12. Receiver Package | NO |

Formboard Item No. 8

## SYMPTOM

Part of the results obtained during a missile systems test are shown below.

| Test | Conditions of Test | Monitoring Panel Reading | Normal Range |
|---|---|---|---|
| Regulated Power Supply Check | External Power | -200 volt supply reads -20 volts | +200±0.2V |
| | | +200 volt supply reads Zero volts | +200±0.2V |
| Primary Internal Power and Low Voltage Check | External Air | Time for power change-over: 0.8 sec. | 0.8 sec. |
| | | Phase Lights: Normal | Normal |
| | | Low Voltage D.C.: +30V | 25-35V |
| | | Alternator Voltage: 110V | 105-121V |
| | | Alternator Frequency: 398cps. | 400cps. |


MISSILE
REGULATED
POWER
SUPPLY
-200 V.
+200 V.
+280 V.
GND.
+325 V.
+325 V.
+325 V.
+370 V.
C403
C402
C401
C404
R406
R405
R404
R403
R402
R407
R102
R103
R104
R208
R207
R206
R205
R204
R226
R203
R202
R201
V209
V404
V207
V208
V401
V402
V403
V211
V210
V202
V203
V204
V205
V206
R218
R220
R224
R223
R219
R222
R215
R216
R217
R211
R212
R213
R209
C201
C101
C102
CH 101
CH 102
CH 103
V104
V103
V102
V101
PS
FIL
X
Y
Z
T101
ØA
T102
ØB
T103
ØC

## C H E C K S

A) **D.C. Voltages**

External 115 V, 400 cycle A.C. used.

| | |
|---|---|
| 1. +200 volts, bus to ground. | Zero V |
| 2. -200 volts, bus to ground. | -20 V |
| 3. Tube V 101, pins to ground. | Normal |
| 4. Tube V 102, pins to ground. | Normal |
| 5. Tube V 103, pins to ground. | Normal |
| 6. Tube V202, pins to ground. | Cathode: -20 V.<br>All other pins Zero volts. |

| | |
|---|---|
| 7. Tube V203, pins to ground. | Cathode: -20 V<br>All other pins Zero volts |
| 8. Tube V204, pins to ground. | Cathode: -20 V<br>All other pins Zero volts |
| 9. Tube V 205, pins to ground. | Zero V all pins |
| 10. Tube V206, pins to ground. | Zero V all pins |
| 11. Tube V207, pins to ground. | Plate: normal<br>Cathode: +1 V<br>Grid: -20 V |
| 12. Tube V 208, pins to ground. | Plate: normal<br>Cathode: +1 V<br>Grid: -20V |
| 13. Tube V 209, pins to ground. | Plates: -20 V<br>Grids: -20 V<br>Cathodes: normal |

| | |
|---|---|
| 14. Tube V 210, pins to ground. | Plate: -20 V<br>Grid: -20 V<br>Cathode: normal |
| 15. Tube V 211, pins to ground. | Plates: -20 V<br>Cathode Follower grid: -20 V<br>Grounded Grid Amplifier grid: Zero V<br>Cathodes: Zero V |
| 16. Tube V 402, pins to ground. | All pins: Zero V |
| 17. Tube V 403, pins to ground. | All pins: -20 V |
| 18. Across C 101. | Higher than normal |
| 19. Across C 102. | Zero V |

B) A.C. Volts

| | |
|---|---|
| 1. **Primary Voltage**<br>T 101 (ϕ A)<br>T 102 (ϕ B)<br>T 103 (ϕ C) | All normal |
| 2. Plate to plate Tube V 101. | Normal |
| 3. Plate to plate Tube V 102. | Normal |
| 4. Plate to plate Tube V 103. | Normal |
| 5. Plate to plate Tube V 104. | Normal |
| 6. Filament winding X-Y, transformer T 102. | Normal |

| | |
|---|---|
| 7. Filament winding, point 2 to ground, transformer T 103. | Normal |

C) <u>Resistance Checks</u>

Resistance measured from tube pins to signal ground unless otherwise noted.
Power to chassis OFF.

| | |
|---|---|
| 1. Tube V 101. | All normal |
| 2. Tube V 102. | All normal |
| 3. Tube V 103. | All normal |
| 4. Tube V 104. | All normal |

| | |
|---|---|
| 5. Tube V 202. | All normal |
| 6. Tube V 203. | All normal |
| 7. Tube V 204. | All normal |
| 8. Tube V 205 | All normal |
| 9. Tube V 206. | All normal |
| 10. Tube V 207. | All normal |
| 11. Tube V 208. | All normal |

| | |
|---|---|
| 12. Tube V 209. | All normal |
| 13. Tube V 211. | All normal |
| 14. Tube V 401. | All normal |
| 15. Tube V 402. | All normal |
| 16. Tube V 403. | All normal |
| 17. Tube V 404. | All normal |

| | |
|---|---|
| 18. Between +200 and -200 volt busses. | Normal |
| 19. Across C 101. | Rises to 20 MEG (Normal) |
| 20. Across C 102. | Rises to 20 MEG (Normal) |
| 21. Across terminals choke CH 101. | Normal |
| 22. Across terminals choke CH 102. | Normal |
| 23. Across terminals choke CH 103. | Infinite |

## UNITS

| | | | |
|---|---|---|---|
| **Tubes** | | | |
| 1. V 101 | NO | 13. V 210 | NO |
| 2. V 102 | NO | 14. V 402 | NO |
| 3. V 103 | NO | 15. V 403 | NO |
| | | **Transformers** | |
| 4. V 104 | NO | 16. T 101 | NO |
| 5. V 202 | NO | 17. T 102 | NO |
| 6. V 203 | NO | 18. T 103 | NO |
| | | **Chokes** | |
| 7. V 204 | NO | 19. CH 101 | NO |
| 8. V 205 | NO | 20. CH 102 | NO |
| 9. V 206 | NO | 21. CH 103 | YES |
| | | **Resistors** | |
| 10. V 207 | NO | 22. R 101 | NO |
| 11. V 208 | NO | 23. R 102 | NO |
| 12. V 209 | NO | 24. R 103 | NO |

| | | | | | |
|---|---|---|---|---|---|
| 25. | R 201 | NO | 38. | R 218 | NO |
| 26. | R 204 | NO | 39. | R 219 | NO |
| 27. | R 205 | NO | 40. | R 220 | NO |
| 28. | R 206 | NO | 41. | R 222 | NO |
| 29. | R 207 | NO | 42. | R 223 | NO |
| 30. | R 208 | NO | 43. | R 224 | NO |
| 31. | R 209 | NO | 44. | R 226 | NO |
| 32. | R 211 | NO | 45. | R 401 | NO |
| 33. | R 212 | NO | 46. | R 402 | NO |
| 34. | R 213 | NO | 47. | R 403 | NO |
| 35. | R 215 | NO | 48. | R 404 | NO |
| 36. | R 216 | NO | 49. | R 405 | NO |
| 37. | R 217 | NO | 50. | R 406 | NO |

Condensers

| | | | |
|---|---|---|---|
| 51. C 101 | NO | 52. C 102 | NO |

Formboard Item No. 9

SYMPTOM

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up completed | GREEN | GREEN | GREEN |
| B | Unit shuts down | - | - | - |

TEST DISCONTINUED

## OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |

FLIGHT READY INDICATOR

## CHECKS

The following checks make use of the Monitoring Panel.

| | |
|---|---|
| 1. **Regulated Power Supply**<br>Turn on external power.<br>Check -200 V output.<br>Check +200 V output.<br>Check Difference Voltage. | All voltages normal |
| 2. **Missile Operate Relay Check**<br>Turn on external power.<br>Turn on Missile Operate Switch.<br>Check Missile Operate light.<br>Check Gyro Caged light. | Missile Operate light: ON<br>Gyro caged light: OFF |
| 3. **Programmer Test**<br>Turn on external power.<br>Turn on Missile Operate Switch.<br>Hold Timer Run Switch for at least 40 sec. After 6 sec., check Guidance Beam and Intercept lights. After 40 sec., check Programmer Meter reading. | All normal |
| 4. **Sustainer Voltage**<br>Check Sustainer voltage using Monitoring Panel VTVM. | Normal |
| 5. **Timer Reset Check**<br>Run Timer to "End of Run".<br>Turn off Timer Run switch.<br>Turn off Missile Operate switch.<br>After 5 sec., check Timer position.<br>After 15 sec., check Gyro Caged light. | All normal |

6. Primary Internal Power and Low Voltage Supply Output

Turn external air on.
Compute power changeover time.
Record alternator voltage.
Record alternator frequency.
Check alternator phasing.
Record +30V output.

| |
|---|
| No power changeover.<br>400cps voltage: normal<br>400cps frequency: normal<br>400cps phasing: normal<br>+30V supply volts: normal |

7. Hydraulic Check

Turn external air on.
Read hydraulic pressure on gauge connected into high pressure side of hydraulic sump.

| |
|---|
| Normal |

8. Receiver Output

Turn on external power.
12db error signal, -15dbm range, fed from Beam Simulator to missile waveguide input.
Error and Reference signal outputs from receiver observed.

| |
|---|
| Normal |

9. Destruct Check

Turn on external power.
Turn Beam Simulator OFF.
Record destruct delay time.

| |
|---|
| Normal |

10. Intelligence Converter Sensitivity

Turn on external power.
With 2db error signal, -15dbm range, phasing DOWN, and timer at 3 sec., read "A" and "B" Computer Monitor voltages.
With 2db error signal, -30dbm range, phasing DOWN, and timer at end of run, read "A" and "B" Computer Monitor voltages.

| |
|---|
| All normal |

11. Wing Speed Check

Turn on external air.
Apply -2.5 V step signal to input of both "A" and "B" servo amplifiers.
Record wing sense.
Take a Brush recording of wing positions as wings are moved from stop to stop with step signals.
Compute maximum wing speeds.

| |
|---|
| Normal |

12. Computer Altitude Correction

Turn on external air.
Set altitude control to 20,000 ft.
Set timer at 22 sec.
Apply 30cps reference and error signals of such magnitude as to obtain 20.0 V Computer Monitor Voltage; phasing DOWN, then UP.
Record "A" and "B" wing positions.

| |
|---|
| Normal |

13. Rolleron Trim Adjustment

Turn on external air.
Ground roll servo amplifier input at VTVM.
Adjust trim pot for zero rolleron angle at center of backlash.

| |
|---|
| Adjusted to Zero degrees. |

14. Rolleron Speed Check

Turn on external air.
Apply +4.5 V step signal to input of roll servo amplifer.
Record rolleron sense.
Take a Brush recording of rolleron position as rolleron is moved from stop to stop with step signals.
Compute maximum rolleron speeds.

| |
|---|
| Normal |

15. Roll Sensitivity and Balance

Turn on external air.
Program Roll Corrector $0^\circ$ to $20^\circ$ CCW to $20^\circ$ CW.
Wait 15 sec. and actuate Missile Operate Relay.
Then do the following.

a. Roll missile to $20^\circ$ CCW.
Read rolleron angle.

| |
|---|
| Rolleron angle: Zero degrees<br>Normal angle: $1/2^\circ$ |

b. Roll missile to $10^\circ$ CCW.
Read rolleron angle.

| |
|---|
| Rolleron angle: Zero degrees<br>Normal angle: 0.7 to $1.9^\circ$ CCW |

c. Actuate separation switch.
Read rolleron angle.

Rolleron angle: Zero degrees
Normal angle: 2.8 to 7.2° CCW

d. Turn altitude switch to 20,000ft.
Read rolleron angle.

Rolleron angle: Zero degrees
Normal angle: an increase in rolleron position

e. Roll missile to 30° CCW.
Read rolleron angle.

Rolleron angle: Zero degrees
Normal angle: 2.8 to 7.2° CCW

16. Roll Rate Change

Turn on external air.
Apply 400cps signal from Graham drive to Roll Channel input.
Vary signal at sine wave rate of 0.1cps, then 5.0cps.
Read pk to pk rolleron angle.
Compute gain ratio.

Normal

17. A.C. Voltage Checks

a. Gyro output. Set VTVM AC Selector Switch to Position 2.
Set roll corrector dial to 20° CCW, then to 20° CW.
Turn on missile operate switch.
Roll missile to 30° CCW.
Observe voltage.

Voltage normal

b. 26V, 400cps (synchro excitation voltage) check.
Set VTVM A.C. Selector Switch to position 3.
Observe voltage.

| |
|---|
| Voltage normal |

c. 110V, 60cps (A.C. supply from panel) check.
Set VTVM A.C. Selector switch to position 3.
Observe voltage.

| |
|---|
| Voltage normal |

## UNITS

| | | | | | |
|---|---|---|---|---|---|
| 1. | Alternator | NO | 12. | Programmer | NO |
| 2. | Regulated Power Supply | NO | 13. | Receiver | NO |
| 3. | Guidance (Steering) System Computer | NO | 14. | Autopak | NO |
| 4. | Roll Free Gyro | NO | 15. | Hydraulic Motor | NO |
| 5. | Booster Firing Circuits | NO | 16. | Low Voltage A.C. Power Supply | NO |
| 6. | Roll Corrector Synchro | NO | 17. | Backscratcher | NO |
| 7. | Gyro Pick-off Synchro | NO | 18. | Rolleron Actuator | NO |
| 8. | Power Changeover Relay | YES | 19. | Roll Servo Valve | NO |
| 9. | Transformer Bank | NO | 20. | Guidance Package Servo Amplifiers | NO |
| 10. | Roll Corrector Synchro Solenoid | NO | 21. | Low Voltage D.C. Supply | NO |
| 11. | Roll Free Gyro Uncage Motor | NO | | | |

Formboard Item No. 10

SYMPTOM

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up Completed | GREEN | RED | RED |
| B | Unit shuts down | - | - | - |

TEST DISCONTINUED

OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |
| FLIGHT READY INDICATOR | | | |

## CHECKS

The following checks make use of the Monitoring Panel.

A) Regulated Power Supply

Turn on external power.
Check -200 V output.
Check +200 V output.
Check Difference Voltage.

| |
|---|
| -200 V: normal<br>+200 V: normal<br>Difference Voltage: normal |

B) Missile Operate Relay Check

Turn on external power.
Turn on Missile Operate switch.
Check Missile Operate light.
Check Gyro Caged light.

| |
|---|
| Missile Operate light goes: ON<br>Gyro Caged light goes: OFF |

C) Timer Reset Check

Run Timer to "End of Run."
Turn off Timer Run switch.
Turn off Missile Operate switch.
After 5 sec., check Timer Position.
After 15 sec., check Gyro Caged Light.

| |
|---|
| Timer Position: Zero sec.<br>Gyro Caged light goes: ON |

D) Primary Internal Power and Low Voltage Supply Output

Turn external air on.
Compute power changeover time.
Record alternator voltage.
Record alternator frequency.
Check alternator phasing.
Record +30 V output.

| |
|---|
| No power changeover<br>400cps voltage: normal<br>400cps frequency: normal<br>Phasing: normal<br>+30 V D.C.: normal |

E) Hydraulic Check

Turn external air on.
Read hydraulic pressure on gauge connected into high pressure side of hydraulic sump.

| |
|---|
| Pressure: Zero |

F) Receiver Output Check

Turn on external power switch.
Signal from Guidance Beam Simulator to missile as follows:
Error signal; +2db
Phasing; DOWN
Range; -15dbm
Read error and reference signal outputs from receiver.

| |
|---|
| 30cps error: normal<br>30cps reference: normal |

G) Intelligence Converter "A" Channel Phasing Adjustment

Turn external power on.
Signal from Beam Simulator: 4db error, -30dbm range.
Adjust phase of signal to all positions in turn.
Adjust phasing pot for minimum computer monitor output.

| |
|---|
| Adjusted normally |

H) Intelligence Converter "B" Channel Phasing Adjustment

Turn external power on.
Signal from Beam Simulator: 4db error, -30 dbm range.
Adjust phase of signal to all positions in turn.
Adjust phasing pot for minimum computer monitor output.

| |
|---|
| Adjusted normally |

I) Wing Trim Adjustment

Turn on external air switch.
Ground Servo Amplifier inputs at VTVM terminals.
Adjust wing trim pots for Zero position of wing protractor pointer.

| |
|---|
| No adjustment can be made on either wing. |

J) Wing Speed Check

Turn on external air.
Apply -2.5 V step signal to input of both "A" and "B" servo amplifiers.
Record wing sense.
Take a Brush recording of wing positions as wings are moved from stop to stop with step signals.
Compute maximum wing speeds.

| |
|---|
| No A or B wing motion. |

K) Computer, Servo Sensitivity and Wing Limits Check

Turn on external air.
Apply 30cps reference and error signals to Intelligence Converter to give computer monitor voltages given below; phase DOWN, then UP.

1. Set timer to 3 sec.
   Adjust signal to give 6 V computer monitor voltage.
   Read wing positions.

| |
|---|
| No A or B wing motion. |

| | |
|---|---|
| 2. Set timer to 10 sec. Adjust signal to give 10 V computer monitor voltage. Read wing positions. | No A or B wing motion. |
| 3. Set timer to 22 sec. Adjust signal to give 10 V computer monitor voltage. Read wing positions. | No A or B wing motion. |
| 4. Set timer to 22 sec. Adjust signal to give 10 V computer monitor voltage. Set altitude to 20,000 ft. Read wing positions. | No A or B wing motion. |
| 5. Set timer to 22 sec. Adjust signal to give 10 V computer monitor voltage. Turn intercept switch OFF. Set integrator switch to Normal. Read wing positions. | No A or B wing motion. |
| 6. Set timer to 22 sec. Set Graham drive for 0.5cps, and apply signal to input Intelligence Converter. Adjust signal so that 2 V pk to pk computer monitor voltage is obtained. Read pk to pk wing positions. | No A or B wing motion. |

L) Rolleron Trim Adjustment

Turn on external air.
Ground roll servo amplifier input at VTVM.
Adjust trim pot for Zero rolleron angle at center of backlash.

| |
|---|
| No adjustment possible. |

M) Rolleron Speed Check

Turn on external air.
Apply +4.5 V step signal to input of roll servo amplifier.
Record rolleron sense.
Take a Brush recording of rolleron position as rolleron is moved from stop to stop with step signals.
Compute maximum rolleron speed.

| |
|---|
| No rolleron motion. |

N) Roll Rate Change

Turn on external air.
Apply 400cps signal from Graham drive to Roll Channel input.
Vary signal at sine wave rate of 0.1cps, then 5.0cps.
Read pk to pk rolleron angle.
Compute gain ratio.

| |
|---|
| No rolleron motion. |

O) Servo Amplifier and Valve Checks

Turn on the external air switch.
Set meter number 1 selector switch to Valve Test.

1. "A" Wing Servo Valve Current

Set Valve Test Selector switch to "A" monitor.
Apply 2.5 V step signal to input "A" channel servo amplifier.
Read valve current.

No valve current

2. "B" Wing Servo Valve Current

Set Valve Test Selector switch to "B" monitor.
Apply ± 2.5 V step signal to input "B" channel servo amplifier.
Read valve current.

No valve current

3. Roll Servo Valve Current

Set Valve Test Selector switch to roll monitor.
Apply ± 4.5 V step signal to input roll servo amplifier.
Read valve current.

No valve current

4. "A" Wing Servo Current with Resistive Network Substituted for Valve

Set Valve Test Selector switch to "A" Test.
Apply ± 2.5 V step signal to input "A" channel servo amplifier.
Read valve current.

No valve current

5. "B" Wing Servo Current with Resistive Network Substituted for Valve

Set Valve Test Selector switch to "B" Test.
Apply +2.5 V step signal to input "B" channel servo amplifier.
Read valve current.

| |
|---|
| No valve current |

6. Roll Servo Current with Resistive Network Substituted for Valve

Set Valve Test Selector switch to Roll Test.
Apply +4.5 V step signal to input roll servo amplifier.
Read valve current.

| |
|---|
| No valve current |

## UNITS

| | | | |
|---|---|---|---|
| 1. Power Supply | NO | 8. Autopak | YES |
| 2. Alternator | NO | 9. "A" Channel Hydraulic Valve | NO |
| 3. Receiver | NO | 10. "B" Channel Hydraulic Valve | NO |
| 4. Intelligence Converter | NO | 11. Roll Channel Hydraulic Valve | NO |
| 5. "A" Channel Servo Amplifier | NO | 12. "A" Channel Hydraulic Actuator | NO |
| 6. "B" Channel Servo Amplifier | NO | 13. "B" Channel Hydraulic Actuator | NO |
| 7. Roll Servo Amplifier | NO | 14. Roll Channel Hydraulic Actuator | NO |

Formboard Item No. 11

S Y M P T O M

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up completed | GREEN | GREEN | GREEN |
| B | Unit shuts down | - | - | - |

TEST DISCONTINUED

## OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |

FLIGHT READY INDICATOR

# CHECKS

The following checks make use of the Monitoring Panel.

A) Regulated Power Supply

| Procedure | Result |
| --- | --- |
| Turn on external power.<br>Check -200 V output.<br>Check +200 V output.<br>Check Difference Voltage. | -200 V normal<br>+200 V: normal<br>Difference Voltage: normal |

B) Missile Operate Relay Check

| Procedure | Result |
| --- | --- |
| Turn on external power.<br>Turn on Missile Operate Switch.<br>Check Missile Operate light.<br>Check Gyro Caged light. | Missile Operate Light comes: ON<br>Gyro Caged light goes: OFF |

C) Timer Reset Check

| Procedure | Result |
| --- | --- |
| Run Timer to "End of Run".<br>Turn off Timer Run switch.<br>Turn off Missile Operate switch.<br>After 5 sec., check Timer position.<br>After 15 sec., check Gyro Caged light. | Timer Position: Zero<br>Gyro Caged Light comes: ON |

D) Primary Internal Power and Low Voltage Supply Output

| Procedure | Result |
| --- | --- |
| Turn external air on.<br>Compute power changeover time.<br>Record alternator voltage.<br>Record alternator frequency.<br>Check alternator phasing.<br>Record +30 V output. | No power changeover<br>400cps Voltage: normal<br>400cps Frequency: normal<br>400cps phasing: normal<br>+30 V D.C.: normal |

E) Hydraulic Check

Turn external air on.
Read hydraulic pressure on gauge connected into high pressure side of hydraulic sump.

Pressure: normal

F) Receiver Output Check

Turn on external power switch.
Signal from Guidance Beam Simulator to missile as follows:
Error signal; +2db
Phasing; DOWN
Range; -15dbm
Read error and reference signal outputs from receiver.

30cps error: normal
30cps reference: normal

G) Intelligence Converter "A" Channel Phasing Adjustment

Turn external power on.
Signal from Beam Simulator: 4db error, -30dbm range.
Adjust phase of signal to all positions in turn.
Adjust phasing pot for minimum computer monitor output.

"A" channel adjusted OK

H) Intelligence Converter "B" Channel Phasing Adjustment

Turn external power on.
Signal from Beam Simulator: 4db error, -30dbm range.
Adjust phase of signal to all positions in turn.
Adjust phasing pot for minimum computer monitor output.

"B" Channel adjusted OK

I) Wing Trim Adjustment

Turn on external air switch.
Ground Servo Amplifier inputs at VTVM terminals.
Adjust wing trim pots for Zero position of wing protractor pointer

| |
|---|
| A and B wings trim normally |

J) Wing Speed Check

Turn on external air.
Apply -2.5 V step signal to input of both "A" and "B" servo amplifiers.
Record wing sense.
Take a Brush recording of wing positions as wings are moved from stop to stop with step signals.
Compute maximum wing speeds.

| |
|---|
| Wing speeds normal |

K) Computer, Servo Sensitivity and Wing Limits Check

Turn on external air.
Apply 30cps reference and error signals to Intelligence Converter to give computer monitor voltages given below; phase DOWN, then UP.

1. Set timer to 3 sec.
   Adjust signal to give 6 V computer monitor voltage.
   Read wing positions.

| |
|---|
| A and B wing positions normal |

| | |
|---|---|
| 2. Set timer to 10 sec. Adjust signal to give 10 V computer monitor voltage. Read wing positions. | A and B wing positions normal |
| 3. Set timer to 22 sec. Adjust signal to give 10 V computer monitor voltage. Read wing positions. | A and B wing positions normal |
| 4. Set timer to 22 sec. Adjust signal to give 10 V computer monitor voltage. Set altitude to 20,000 ft. Read wing positions. | A and B wing positions normal |
| 5. Set timer to 22 sec. Adjust signal to give 10 V computer monitor voltage. Turn intercept switch OFF. | A and B wing positions normal |
| 6. Set timer to 22 sec. Set Graham drive for 0.5cps, and apply signal to input Intelligence Converter. Adjust signal so that 2 V pk to pk is obtained. Read pk to pk wing positions. | A and B wingsdeflect normally |

L) Rolleron Trim Adjustment

Turn on external air.
Ground roll servo amplifier input at VTVM.
Adjust trim pot for Zero rolleron angle at center of backlash.

| |
|---|
| Rolleron can be trimmed normally |

M) Rolleron Speed Check

Turn on external air.
Apply +4.5 V step signal to input of roll servo amplifier.
Record rolleron sense.
Take a Brush recording of rolleron position as rolleron is moved from stop to stop with step signals.
Compute maximum rolleron speed.

| |
|---|
| Rolleron speed normal |

N) Roll Rate Change

Turn on external air.
Apply 400cps signal from Graham drive to Roll Channel input.
Vary signal at sine wave rate of 0.1cps, then 5.0cps.
Read pk to pk rolleron angle.
Compute gain ratio.

| |
|---|
| Normal |

O) Servo Amplifier and Valve Checks

Turn on the external air switch.
Set meter number 1 selector switch to Valve Test.

1. "A" Wing Servo Valve Current

Set Valve Test Selector switch to "A" monitor.
Apply +2.5 V step signal to input "A" channel servo amplifier.
Read valve current

| Normal |
|---|

2. "B" Wing Servo Valve Current

Set Valve Test Selector switch to "B" monitor.
Apply +2.5 V step signal to input "B" channel servo amplifier.
Read valve current.

| Normal |
|---|

3. Roll Servo Valve Current

Set Valve Test Selector switch to roll monitor.
Apply +4.5 V step signal to input roll servo amplifier.
Read valve current.

| Normal |
|---|

4. "A" Wing Servo Current with Resistive Network Substituted for Valve

Set Valve Test Selector switch to "A" Test.
Apply +2.5 V step signal to input "A" channel servo amplifier.
Read valve current.

| Normal |
|---|

5. <u>"B" Wing Servo Current with Resistive Network Substituted for Valve</u>

Set Valve Test Selector Switch to "B" Test.
Apply +2.5 V step signal to input "B" channel servo amplifier.
Read valve current.

| |
|---|
| Normal |

6. <u>Roll Servo Current with Resistive Network Substituted for Valve</u>

Set Valve Test Selector switch to Roll Test.
Apply +4.5 step signal to input roll servo amplifier.
Read valve current.

| |
|---|
| Normal |

## UNITS

| | | | | | |
|---|---|---|---|---|---|
| 1. | Power Supply- | NO | 8. | Alternator or Hydraulic Motor | YES |
| 2. | Receiver | NO | 9. | "A" Channel Hydraulic Valve | NO |
| 3. | Intelligence Converter | NO | 10. | "B" Channel Hydraulic valve | NO |
| 4. | "A" Channel Servo Amplifier | NO | 11. | Roll Channel Hydraulic Valve | NO |
| 5. | "B" Channel Servo Amplifier | NO | 12. | "A" Channel Hydraulic Actuator | NO |
| 6. | Roll Channel Servo Amplifier | NO | 13. | "B" Channel Hydraulic Actuator | NO |
| 7. | Autopak | NO | 14. | Roll Channel Hydraulic Actuator | NO |

Formboard Item No. 12

## SYMPTOM

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up completed OK | GREEN | GREEN | RED |
| B | Unit did not shut down | GREEN | GREEN | RED |
| C | Meters 1 and 2 inoperative in this position | - | - | GREEN |
| D | Meter 3 goes to Zero after 40 sec. | GREEN | GREEN | GREEN |
| E | | GREEN | GREEN | GREEN |
| F | | GREEN | GREEN | GREEN |
| G | | GREEN | GREEN | GREEN |
| OFF | Gyro cages | | | |

## OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |

FLIGHT READY INDICATOR

## CHECKS

The following checks make use of the Monitoring Panel.

A) Regulated Power Supply Output

External power used.

| |
|---|
| +200 Volts: normal<br>-200 Volts: normal<br>Difference Voltage: normal |

B) Actuate Missile Operate Relay Switch

Check gyro caged light.
Check missile operate light.

| |
|---|
| Gyro caged light goes OFF.<br>Missile operate light goes ON. |

C) Programmer Check

Turn on Missile Operate switch.
Hold Timer Run switch ON for more than 40 sec.
After 6 sec., check Guidance Beam and Intercept lights.
After 40 sec., check Timer position.

| |
|---|
| Guidance Beam light: ON<br>Intercept light: ON<br>Timer position at 40 sec.: end-of-flight. |

D) Timer Reset Check

Run Timer to "End of Run"
Turn off Timer Run switch.
Turn off Missile Operate switch.
After 5 sec., check timer position.
After 15 sec., check Gyro Caged light.

| |
|---|
| Timer Position: Zero<br>Gyro Caged Light: ON |

E) Primary Internal Power and Low Voltage

Turn on external air.
Check power changeover time from alternator voltage record.
Check alternator phasing.
Check alternator output voltage and frequency.
Check low voltage D.C. output.

| |
|---|
| Power changeover time: normal<br>Phase lights: normal<br>Alternator output voltage and frequency: normal<br>Low Voltage: normal |

F) Hydraulic Pressure

Turn on External air switch.
Read hydraulic pressure on gauge connected to high pressure side of hydraulic sump.

| |
|---|
| Pressure: normal |

G) Receiver Output

12db error signal from Beam Simulator to missile wave guide input.
Read error and reference output from receiver.

| |
|---|
| Reference volts: normal<br>Error volts: normal |

H) Wing Speed Check

Turn on External air switch.
Apply 2.5 volts D.C. step signal to input computer cathode follower.
Record wing position and compute maximum wing speed.

| |
|---|
| A and B wing speeds: normal |

I) Computer and Servo Sensitivity

Turn on External air switch.
Signal from Monitoring Panel:
30cps reference and error signals to input intelligence converter; phasing: DOWN
Set timer to 3 sec.
Read computer monitor volts and wing position.

Computer volts: normal
Wing position: normal

J) Rolleron Trim Adjustment

Turn on External air switch.
Ground servo amplifier input at VTVM.
Adjust trim pot for Zero degrees rolleron position

Rolleron remains against
CW stop
Adjustment of trim
pot has no effect

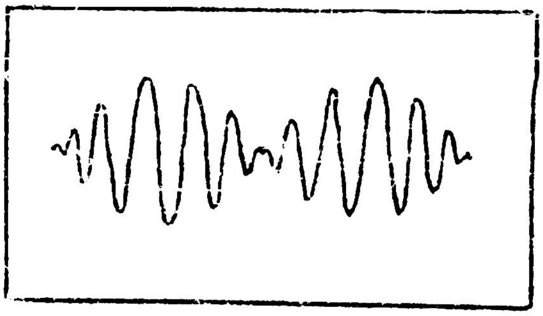
K) Rolleron Speed Check

Turn on External air switch.
Apply 4.5 volt D.C. step signal to input roll servo amplifier.
Record rolleron position and compute maximum speed.

No rolleron motion

L) Gyro Pick-off Synchro Output

Rotate missile by hand.
Observe output on scope.



M) **Roll System Gain Test**

Turn on External air switch.
Position missile in stand at 67 1/2°CW.
Set Monitoring Panel roll corrector dial to 20°CCW, then to 20°CW.
Operate the missile operate switch.

| | |
|---|---|
| 1. Roll missile in stand to 20°CCW. Observe rolleron angle. | No rolleron movement rolleron at CW stop |
| 2. Roll missile to 10°CCW position. Observe rolleron angle. | No rolleron movement, rolleron at CW stop |
| 3. Actuate separation switch. Observe rolleron angle. | No rolleron movement, rolleron at CW stop |
| 4. Turn altitude switch to 20,000 ft. Observe rolleron angle. | No rolleron movement, rolleron at CW Stop |

N) **Roll amplifier and valve check**

Turn on External air switch.

1. Apply 4.5V D.C. signal to input roll servo amplifier.
   Observe Rolleron Protractor.
   Reverse signal polarity and repeat.

   > No rolleron movement, rolleron at CW stop

2. Set Selector switch for Monitoring Panel Meter 1 to VALVE CURRENT.
   Set valve test selector switch to ROLL TEST.
   Apply 4.5 V step signal to Roll Servo input.
   Change polarity switch back and forth.
   Observe deflections of Meter 1 either side of Zero.

   > Meter readings do not balance

3. Set Selector switch for Monitoring Panel Meter 1 to VALVE CURRENT.
   Set valve test selector switch to ROLL MONITOR.
   Apply 4.5 V step signal to Roll Servo input.
   Change polarity switch back and forth.
   Observe deflections of Meter 1 either side of Zero.

   > Valve current: normal

o) <u>Check D.C. voltages with VTVM</u>

Roll missile to 20 CCW with roll corrector dial at 20°CW.
Apply external power.
Operate missile operate switch.

| | |
|---|---|
| 1. Read input to roll servo amplifier. | Normal |
| 2. Measure output of +200V D.C. power supply. | Normal |
| 3. Measure output of -200V D.C. power supply. | Normal |
| 4. Measure ±200V Difference Voltage. | Normal |

P) Check A.C. voltages with VTVM

| | |
|---|---|
| 1. Measure roll signal to demodulator drivers. | Normal |
| 2. Measure gyro output. | Normal |
| 3. Measure 26 volt, 400 cycle supply | Normal |
| 4. Measure 30 cycle reference signal at Receiver output. | Normal |

| | |
|---|---|
| 5. Measure 30 cycle error signal at Receiver output. | Normal |

## UNITS

| | | | |
|---|---|---|---|
| 1. Power supply | NO | 12. Phase comparator | NO |
| 2. Hydraulic system | NO | 13. Rate network | NO |
| 3. Air system | NO | 14. D.C. amplifier | NO |
| 4. Programmer and timer | NO | 15. Servo amplifier | NO |
| 5. Receiver | NO | 16. Hydraulic valve and rolleron actuator | YES |
| 6. Booster firing circuit | NO | | |
| 7. Power changeover circuit | NO | | |
| 8. Roll corrector synchro | NO | | |
| 9. Gyro pick-off synchro | NO | | |
| 10. Inverse pressure pot | NO | | |
| 11. Gain change amplifier | NO | | |

Formboard Item No. 13

## SYMPTOM

| FRI Check Sheet Switch Position | Comments | Meter 1 | Meter 2 | Meter 3 |
|---|---|---|---|---|
| A | Warm-up completed | RED | GREEN | GREEN |
| B | Unit does not shut down | RED | GREEN | GREEN |
| C | Meters 1 and 2 inoperative in this position | - | - | GREEN |
| D | Meter 3 goes to Zero after 40 sec. | RED | GREEN | GREEN |
| E | | RED | GREEN | GREEN |
| F | | RED | GREEN | GREEN |
| G | | RED | GREEN | GREEN |
| OFF | Gyro cages | | | |

Note: Both wings and rollerons were zeroed mechanically at time of protractor installation and before power was applied to missile.

## OPERATING INSTRUCTIONS

ADVANCE KNOB TO "A" TO BEGIN TESTS. WAIT 2 MINUTES FOR WARM-UP.
ADVANCE KNOB TO "B" WHEN METERS COME TO REST AFTER WARM-UP.
ADVANCE KNOB TO SUBSEQUENT POSITIONS AFTER METERS ARE AT REST.
METERS AT REST IN "GREEN" AREAS INDICATE FUNCTIONS IN TOLERANCE.
METERS AT REST IN "RED" AREAS INDICATE FUNCTIONS OUT OF TOLERANCE.
TURN KNOB TO "OFF" TO SHUT DOWN MISSILE.
MISSILE SHUTS DOWN WHEN GYRO CAGES.

| SWITCH | A METER | B METER | R METER |
|---|---|---|---|
| A | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON ZERO ROLL DEMODULATOR BALANCE |
| B | "A" WING ZERO DURING BOOST PHASE | "B" WING ZERO AND FIRING INTERLOCK | ROLLERON POSITION AT 1/4 GAIN, ROLL SENSE |
| C | MISSILE TIMER BEGINS OPERATION | | DESTRUCT OPERATION |
| D | "A" SYSTEM ZERO | "B" SYSTEM ZERO | TIMER AT 40 SEC POSITION |
| E | "A" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | "B" FLOATING LIMITS (GUIDANCE PACKAGE GAIN) | FUZE CRYSTAL CURRENT |
| F | "A" FLOATING LIMITS (REVERSE PHASE) | "B" FLOATING LIMITS (REVERSE PHASE) | FUZE AMPLIFIER CURRENT |
| G | "A" SYSTEM ZERO | "B" SYSTEM ZERO | FUZE OSCILLATOR CURRENT |
| FLIGHT READY INDICATOR | | | |

## CHECKS

**A) Regulated Power Supply**

| Procedure | Result |
|---|---|
| Turn on external power.<br>Check -200 V output.<br>Check +200 V output.<br>Check Difference Voltage. | -200 V: normal<br>+200 V: normal<br>Difference Voltage: normal |

**B) Missile Operate Relay Check**

| Procedure | Result |
|---|---|
| Turn on external power.<br>Turn on Missile Operate Switch.<br>Check Missile Operate light.<br>Check Gyro Caged light. | Missile Operate light comes ON<br>Gyro Caged light goes OFF |

**C) Timer Reset Check**

| Procedure | Result |
|---|---|
| Run timer to "End of Run".<br>Turn off Timer Run switch.<br>Turn off Missile Operate switch.<br>After 5 sec., check Timer Position.<br>After 15 sec., check Gyro Caged Light. | Timer Position: Zero<br>Gyro Caged light comes ON |

**D) Primary Internal Power and Low Voltage Supply Output**

| Procedure | Result |
|---|---|
| Turn external air on.<br>Compute power changeover time.<br>Record alternator voltage.<br>Record alternator frequency.<br>Check alternator phasing.<br>Record +30 V output. | Power changeover time: normal<br>Alternator voltage: normal<br>Alternator frequency: normal<br>Alternator phasing: normal<br>+30 volt output: normal |

**E) Hydraulic Check**

| Procedure | Result |
|---|---|
| Turn external air on.<br>Read hydraulic pressure on gauge connected into high pressure side of hydraulic sump. | Pressure: normal |

F) Receiver Output Check

| Procedure | Result |
|---|---|
| Turn on external power switch. Signal from Guidance Beam Simulator to missile as follows: Error signal: +2db Phasing: DOWN Range: -15dbm Read error and reference signal outputs from receiver. | 30cps error: normal<br>30cps reference: normal |

G) Intelligence Converter "A" Channel Phasing Adjustment

| Procedure | Result |
|---|---|
| Turn external power on. Signal from Beam Simulator: 4db error, -30dbm range. Adjust phase of signal to all positions in turn. Adjust phasing pot for minimum computer monitor output. | "A" channel adjusted OK |

H) Intelligence Converter "B" Channel Phasing Adjustment

| Procedure | Result |
|---|---|
| Turn external power on. Signal from Beam Simulator: 4db error, -30dbm range. Adjust phase of signal to all positions in turn. Adjust phasing pot for minimum computer monitor output. | "B" channel adjusted OK |

I) Wing Trim Adjustment

| Procedure | Result |
|---|---|
| Turn on external air switch. Ground Servo Amplifier inputs at VTVM terminals. Adjust wing trim pots for Zero position of wing protractor pointer. | "A" wings at CW stop<br>"B" wings adjust to Zero position |

J) <u>Wing Speed Check</u>

Turn on external air.
Apply -2.5 V step signal to input of both "A" and "B" servo amplifiers.
Record wing sense.
Take a Brush recording of wing positions as wings are moved from stop to stop with step signals.
Compute maximum wing speeds.

> Channel "A": Wings against CW stop. No motion.
> Channel "B": Normal wing speed.

K) <u>Computer, Servo Sensitivity and Wing Limits Check</u>

Turn on external air.
Apply 30cps reference and error signals to Intelligence Converter to give computer monitor voltages given below; phase DOWN, then UP.

1. Set timer to 3 sec.
   Adjust signal to give 6 V computer monitor voltage.
   Read wing positions.

> "A" Wings: out of tolerance, against CW stop.
> "B" Wings: normal position.

2. Set timer to 10 sec.
   Adjust signal to give 10 V computer monitor voltage.
   Read wing positions.

> "A" Wings: out of tolerance, against CW stop.
> "B" Wings: normal position.

3. Set timer to 22 sec.
   Adjust signal to give 10 V computer monitor voltage.
   Read wing positions.

> "A" Wings: out of tolerance, against CW stop.
> "B" Wings: normal position.

4. **Set timer to 22 sec.**
   Adjust signal to give 10 V computer monitor voltage.
   Set altitude to 20,000 ft.
   Read wing positions.

   > "A" Wings: out of tolerance, against CW stop.
   > "B" Wings: normal position.

5. Set timer to 22 sec.
   Adjust signal to give 10 V computer monitor voltage.
   Turn intercept switch OFF.
   Set integrator switch to Normal
   Read Wing positions.

   > "A" Wings: out of tolerance against CW stop.
   > "B" Wings: normal position

6. Set timer to 22 sec.
   Set Graham drive for 0.5 cps, and apply signal to input Intelligence Converter.
   Adjust signal so that 2 volt pk to pk computer monitor voltage is obtained.
   Read pk to pk wing positions.

   > "A" Wings: no motion, wings against CW stop.
   > "B" Wings: normal

L) Rolleron Trim Adjustment

Turn on external air.
Ground roll servo amplifier input at VTVM.
Adjust trim pot for Zero rolleron angle at center of backlash.

> Rollerons trim normally.

M) Rolleron Speed Check

Turn on external air.
Apply +4.5 V step signal to input of roll servo amplifier.
Record rolleron sense.
Take a Brush recording of rolleron position as rolleron is moved from stop to stop with step signals.
Compute maximum rolleron speed.

| |
|---|
| Rolleron speed: normal |

N) Roll Rate Change

Turn on external air.
Apply 400cps signal from Graham drive to Roll Channel input.
Vary signal at sine wave rate of 0.1cps, then 5.0cps.
Read pk to pk rolleron angle.
Compute gain ratio.

| |
|---|
| Gain Ratio: normal |

O) Servo Amplifier and Valve Checks

Turn on the external air switch
Set meter number 1 selector switch to Valve Test.

1. "A" Wing Servo Valve Current
   Set Valve Test Selector switch to "A" monitor.
   Apply ±2.5 V step signal to input "A" channel servo amplifier.
   Read valve current.

| |
|---|
| Valve current constant as polarity switch is changed. Meter reads high positive current. |

2. "B" Wing Servo Valve Current

Set Valve Test Selector switch to "B" monitor.
Apply ±2.5 V step signal to input "B" channel servo amplifier.
Read valve current.

| |
|---|
| Valve current changes in normal manner. |

3. Roll Servo Valve Current

Set Valve Test Selector switch to roll monitor.
Apply ±4.5 V step signal to input roll servo amplifier.
Read valve current.

| |
|---|
| Valve current changes in normal manner. |

4. "A" Wing Servo Current with Resistive Network Substituted for Valve

Set Valve Test Selector switch to "A" Test.
Apply ±2.5 V step signal to input "A" channel servo amplifier.
Read valve current.

| |
|---|
| Valve current changes in normal manner. |

5. "B" Wing Servo Current with Resistive Network Substituted for Valve

Set Valve Test Selector switch to "B" Test.
Apply ±2.5 V step signal to input "B" channel servo amplifier.
Read valve current.

| |
|---|
| Valve current changes in normal manner. |

6. **Roll Servo Current with Resistive Network Substituted for Valve**

Set Valve Test Selector switch to Roll Test.
Apply +4.5 V step signal to input roll servo amplifier.
Read valve current.

| |
|---|
| Valve current changes in normal manner. |

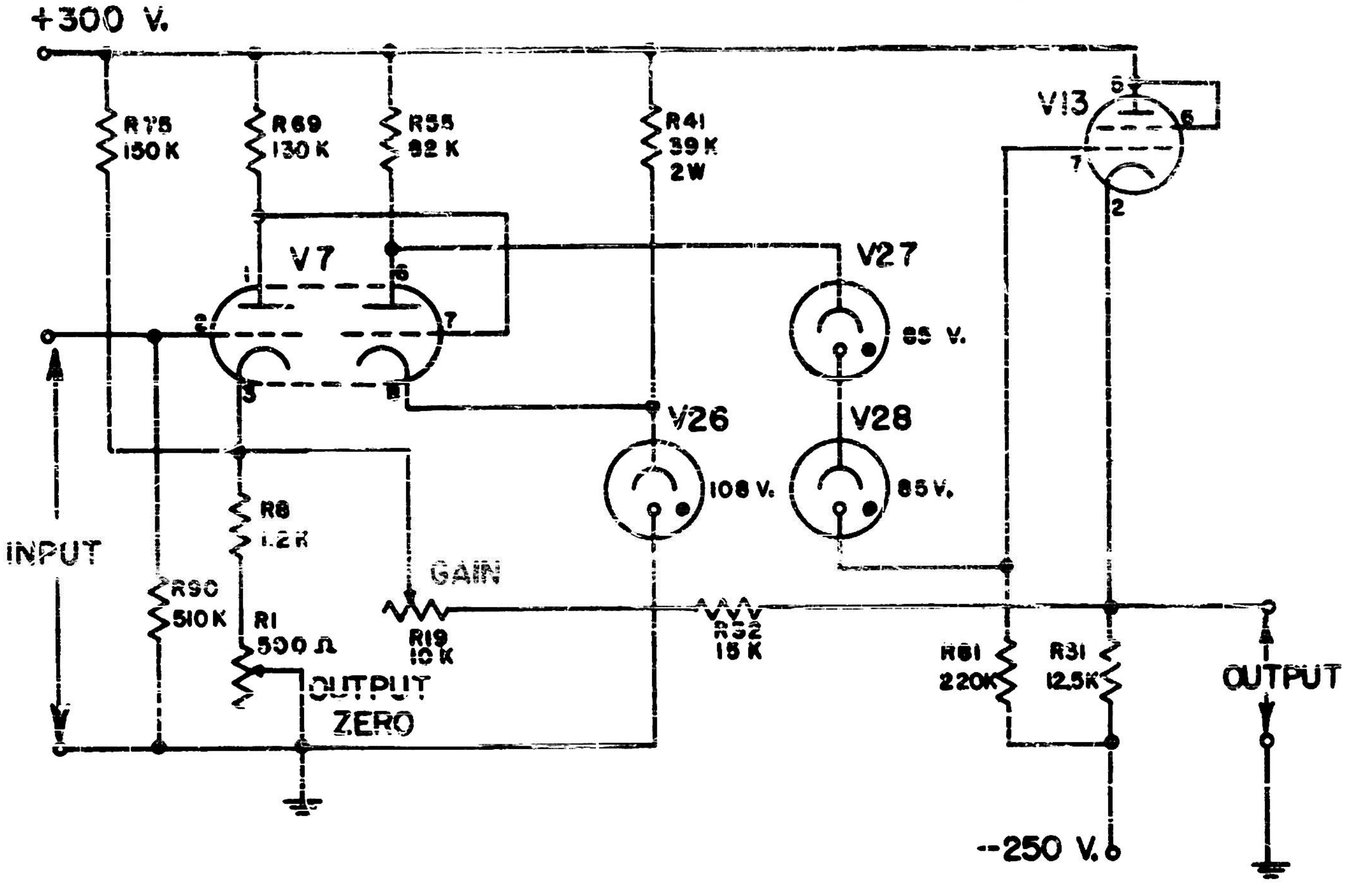
## UNITS

| | | | | | |
|---|---|---|---|---|---|
| 1. | Power Supply | NO | 8. | Alternator | NO |
| 2. | Receiver | NO | 9. | "A" Channel Hydraulic Valve | YES |
| 3. | Intelligence Converter | NO | 10. | "B" Channel Hydraulic Valve | NO |
| 4. | "A" Channel Servo Amplifier | NO | 11. | Roll Channel Hydraulic Valve | NO |
| 5. | "B" Channel Servo Amplifier | NO | 12. | "A" Channel Hydraulic Actuator | NO |
| 6. | Roll Servo Amplifier | NO | 13. | "B" Channel Hydraulic Actuator | NO |
| 7. | Autopak | NO | 14. | Roll Channel Hydraulic Actuator | NO |

Formboard Item No. 14

S I M P T O M

No output signal is obtained from a No. 1 Monitoring Panel D.C. Amplifier. Output terminal cannot be balanced to ground.

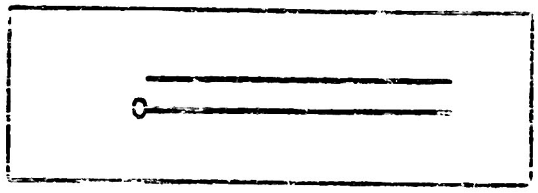



MONITORING PANEL D.C. AMPLIFIER

## CHECKS

A) Output Check

Apply a 20cps signal from an audio signal generator to the input terminals. Check wave form at output terminals with scope.



B) Gain Control

Rotate gain control potentiometer through its range. Observe effect on output.

No effect

C) "Output Zero" Control

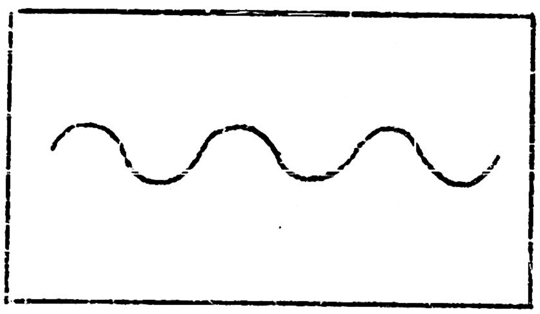
Rotate control through its entire range. Observe effect on output.

No effect

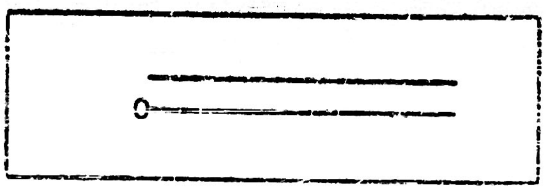
D) Wave form Checks with D.C. Oscilloscope

A 20cps signal is applied to input terminals. The signals appearing at the following points are observed.

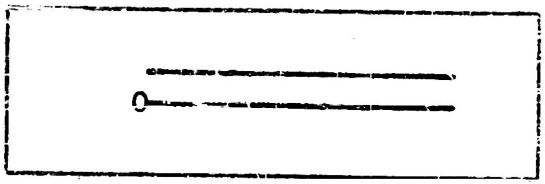
1. Output of 1st section of tube V7 (pin 1 to ground.



2. Output of 2nd section of tube V7 (pin 6 to ground)




3. Output of tube V13 (pin 2 to ground)




E) D.C. Voltage Measurements

1. B+ to ground — +300 V

2. B- to ground — -250 V

3. Pin 1, tube V7, to ground — +99 V

4. Pin 3, tube V7, to ground — +4.9 V

5. Pin 1, tube V26, to ground — +108 V

| | |
|---|---|
| 6. Pin 1, tube V27, to ground | +300 V |
| 7. Pin 1, tube V28, to ground | +215 V |
| 8. Pin 7, tube V13, to ground (same as pin 2, tube V28, to ground) | +107 V |
| 9. Pin 5, tube V13, to ground | +300 V |
| 10. Pin 2, tube V13, to ground | +122 V |

F) Resistance Checks
Resistance measured from tube pins to signal ground with power off and tubes in place.

1. Tube V7

| Pin | Resistance | Pin | Resistance |
|---|---|---|---|
| 1 | 168 K | 6 | 35 K |
| 2 | 520 K | 7 | 168 K |
| 3 | 1.6 K | 8 | 70 K |
| 4 | 0 | 9 | 0 |
| 5 | 0 | | |

2. Tube V13

| Pin | Resistance |
|---|---|
| 2 | 13 K |
| 3 | 0 |
| 4 | 0 |
| 5 | 33 K |
| 6 | 33 K |
| 7 | 240 K |

3. Tube V26

| Pin | Resistance |
|---|---|
| 1 | 70 K |
| 2 | 0 |

4. Tube V27

| Pin | Resistance |
|---|---|
| 1 | 118 K |
| 2 | Infinite |

5. Tube V28

| Pin | Resistance |
|---|---|
| 1 | Infinite |
| 2 | 240 K |

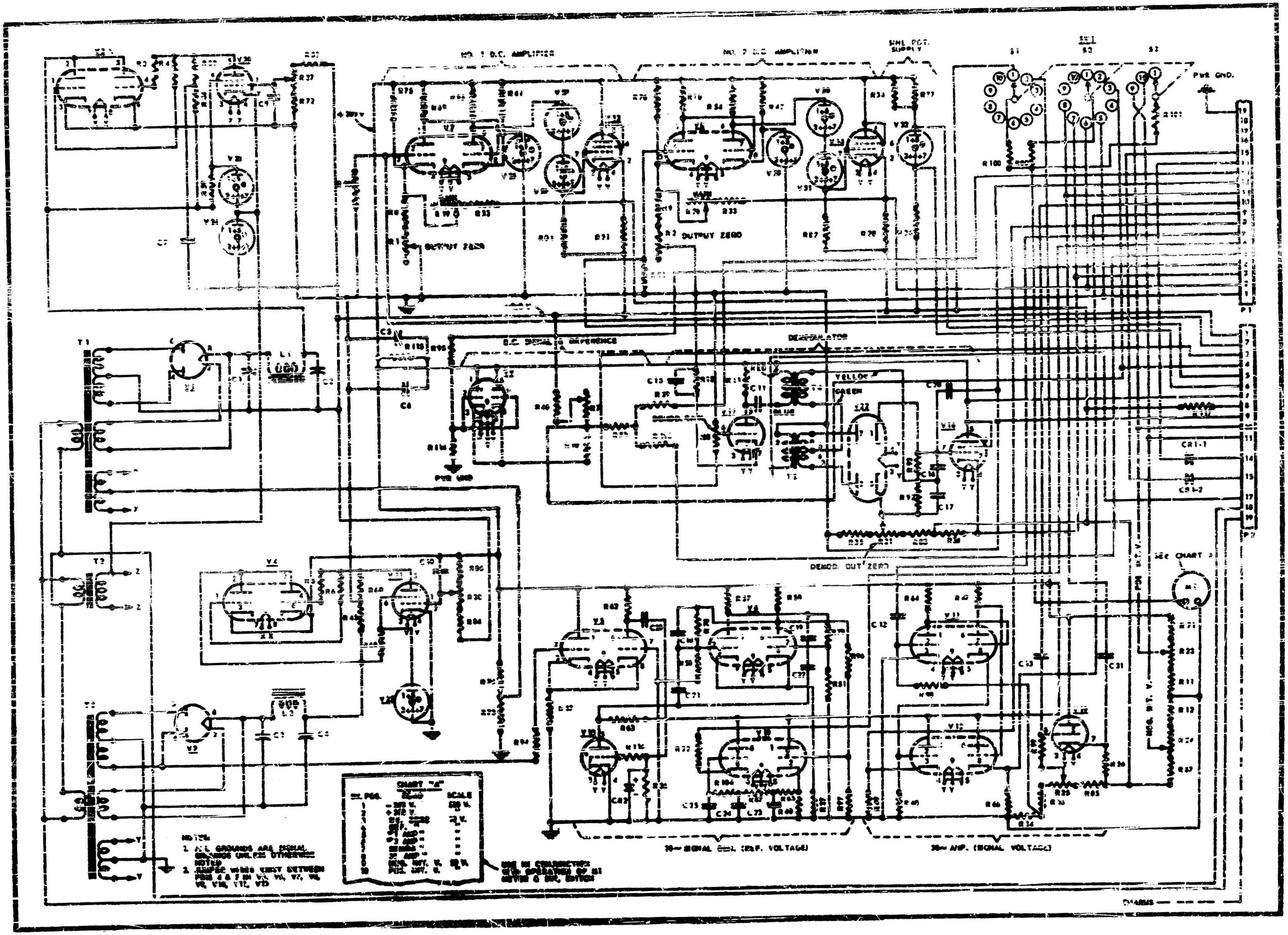
## UNITS

| | | | | |
|---|---|---|---|---|
| **Controls** | | | | |
| 1. "Output Zero" control (R1) | NO | 9. | R31 | NO |
| 2. Gain Control (R19) | NO | 10. | R32 | NO |
| **Tubes** | | | | |
| 3. V7 | NO | 11. | R41 | NO |
| 4. V13 | NO | 12. | R55 | YES |
| 5. V26 | NO | 13. | R69 | NO |
| 6. V27 | NO | 14. | R75 | NO |
| 7. V28 | NO | 15. | R81 | NO |
| **Resistors** | | | | |
| 8. R8 | NO | | | |

Formboard Item No. 15

## SYMPTOM

No signal output from either D.C. amplifier of the Monitoring Panel electronic chassis.


NO. 1 D.C. AMPLIFIER
NO. 2 D.C. AMPLIFIER
S1
S2
PWR GND.
OUTPUT ZERO
OUTPUT ZERO
D.C. SIGNAL REFERENCE
DEMODULATOR
YELLOW
GREEN
BLUE
PWR GND
DEMOD. OUT ZERO
SEE CHART A
CHART "A"
SCALE
NOTES:
30~ SIGNAL CHL. (REF. VOLTAGE)
30~ AMP. (SIGNAL VOLTAGE)
P1
P2

## CHECKS

A) Voltage check using meter M-1 on the electronic chassis

Rotate switch SW-1 to all positions indicated and observe voltage readings.

| | |
|---|---|
| Rotate switch SW-1 to all positions indicated and observe voltage readings. | All voltages are Zero |

B) D.C. voltage check of tubes in amplifiers #1 and #2

Measure voltages from the tube pins to ground with power on.

| | |
|---|---|
| 1. Tube V7 | All D.C. voltages zero |
| 2. Tube V8 | All D.C. voltages zero |
| 3. Tube V13 | All D.C. voltages zero |
| 4. Tube V14 | All D.C. voltages zero |
| 5. Tube V26 | All D.C. voltages zero |

| | |
|---|---|
| 6. Tube V27 | All D.C. voltages zero |
| 7. Tube V28 | All D.C. voltages zero |
| 8. Tube V29 | All D.C. voltages zero |
| 9. Tube V30 | All D.C. voltages zero |
| 10. Tube V31 | All D.C. voltages zero |

C) D.C. voltage checks of tubes in power supply
Measure voltages from the tube pins to ground with power on.

1. Tube V1

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 2 | Zero | +143V |
| 4 | Zero | -252V |
| 6 | Zero | -252V |
| 8 | Zero | +143V |

2. Tube V2

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 2 | +403V | +403V |
| 4 | ZeroV | 2.5V |
| 6 | ZeroV | 2.5V |
| 8 | +403V | +403V |

3. Tube V3

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 1 | Zero | -48 |
| 2 | +370 | +121 |
| 3 | Zero | Zero |
| 4 | Zero | -48 |
| 5 | +370 | +121 |
| 6 | Zero | Zero |

4. Tube V4

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 1 | + 40V | +260V |
| 22 | +403V | +390V |
| 3 | ZeroV | +300V |
| 4 | +40V | +260V |
| 5 | +403V | +390V |
| 6 | ZeroV | +300V |

5. Tube V20

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 1 | ZeroV | +159V |
| 5 | ZeroV | -49V |
| 6 | ZeroV | -77V |
| 7 | ZeroV | +161V |

6. Tube V21

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 1 | ZeroV | -2.5V |
| 5 | +40V | +260V |
| 6 | +84V | +84V |
| 7 | ZeroV | ZeroV |

7. Tube V23

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 1 | Zero V | -77V |
| 2 | ZeroV | -161V |

8. Tube V24

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 1 | ZeroV | -161V |
| 2 | ZeroV | -250V |

9. Tube V25

| Pins | Voltage | Normal Voltage |
|---|---|---|
| 1 | +84V | +84V |
| 2 | ZeroV | ZeroV |

D) D.C. Voltage checks across power supply filter capacitors and chokes

1. D.C. voltage across filter capacitor C1

| Actual | Normal |
|---|---|
| 420 V | 393 V |

2. D.C. voltage across filter capacitor C2

| Actual | Normal |
|---|---|
| 420 V | 371 V |

3. D.C. voltage across filter capacitor C3

| Actual | Normal |
|---|---|
| 420 V | 303 V |

4. D.C. voltage across filter capacitor C4

| Actual | Normal |
|---|---|
| 420 V | 390 V |

5. D.C. voltage across filter choke L1

| Actual | Normal |
|---|---|
| 0 V | 22 V |

6. D.C. voltage across filter choke L2

| Actual | Normal |
|---|---|
| Zero V | 13 V |

E) A.C. voltage checks

Power on meters give RMS values.

1. A.C. input to electronic chassis.
   Observe voltage between pins 18 - 19 on plug P2.

   115 V A.C.

2. Tube V1

| Between Pins | Voltage | Normal |
|---|---|---|
| 4 and 6 | 840 V | 840 V |
| 2 and 8 | 5.0 V | 5.0 V |

3. Tube V2

| Between Pins | Voltage | Normal |
|---|---|---|
| 4 and 6 | 840 V | 840 V |
| 2 and 8 | 5.0 V | 5.0 V |

4. Tube V3

| Between Pins | Voltage | Normal |
|---|---|---|
| 7 and 8 | Zero V | 6.3 V |

5. Tube V4

| Between Pins | Voltage | Normal |
|---|---|---|
| 7 and 8 | Zero V | 6.3 V |

6. Tube V7

| Between Pins | Voltage | Normal |
|---|---|---|
| 4 and 9 | 6.3 V | 6.3 V |

7. Tube V8

| Between Pins | Voltage | Normal |
|---|---|---|
| 4 and 9 | 6.3 V | 6.3 V |

8. Tube V13

| Between Pins | Voltage | Normal |
|---|---|---|
| 3 and 4 | 6.3 V | 6.3 V |

9. Tube V14

| Between Pins | Voltage | Normal |
|---|---|---|
| 3 and 4 | 6.3 V | 6.3 V |

10. Tube V20

| Between Pins | Voltage | Normal |
|---|---|---|
| 3 and 4 | 6.3 V | 6.3 V |

11. Tube V21

| Between Pins | Voltage | Normal |
|---|---|---|
| 3 and 4 | 6.3 V | 6.3 V |

## UNITS

| | | | |
|---|---|---|---|
| **Tubes** | | | |
| 1. V1 | NO | 13. V25 | NO |
| 2. V2 | NO | **Capacitors** 14. C1 | NO |
| 3. V3 | NO | 15. C2 | NO |
| 4. V4 | NO | 16. C3 | NO |
| 5. V7 | NO | 17. C4 | NO |
| 6. V8 | NO | 18. C5 | NO |
| 7. V13 | NO | 19. C6 | NO |
| 8. V14 | NO | 20. C9 | NO |
| 9. V20 | NO | 21. C10 | NO |
| 10. V21 | NO | **Chokes** 22. L1 | NO |
| 11. V23 | NO | 23. L2 | NO |
| 12. V24 | NO | **Transformers** 24. T1 | YES |

25. T2 $\boxed{\text{NO}}$

26. T3 $\boxed{\text{NO}}$

APPENDIX C

INSTRUCTIONS FOR ADMINISTERING THE
TROUBLE-SHOOTING FORMBOARD ITEMS

# APPENDIX C

## INSTRUCTIONS FOR ADMINISTERING THE TROUBLE-SHOOTING FORMBOARD ITEMS

(To be given orally in conjuction with trouble-shooting formboard item No. 1)

This is a test of your ability to trouble-shoot the Terrier missile and its associated equipment. This test will be different from any test that you have ever taken before so please listen to the instructions carefully.

The test is composed of a number of problems. In each problem you are given a symptom which describes a malfunctioning of the missile or a piece of missile test equipment. Your task is to perform certain checks and determine the cause of the symptom.

The first problem is placed in front of you, (Examiner refers to formboard item No. 1 placed on table in front of the trainee). You will note that on your left there is a card with the word SYMPTOM written on it. There is a similar card for each problem. The card describes some malfunction, or out of tolerance condition of the missile or a piece of missile test equipment. A different symptom is given for each problem.

Read the symptom for this first problem to yourself while I read it aloud.

> "During a Monitoring Panel check on a Terrier Receiver the Beam Simulator is set for 12 db error signal and -15 dbm range.
>
> The Receiver output is measured and results obtained are as follows: The 30 cps reference voltage measures zero volts. Its normal value is 1 to 1.4 volts. The 30 cps error voltage measures 5.1 volts. Its normal value is 4.3 to 5.3 volts."

In other words this symptom tells you that the 30 cps error voltage coming from the Receiver is normal but that there is no reference voltage present at the Receiver output.

Note that there is a block diagram of the Terrier receiver accompanying this problem. You can refer to this as you trouble-shoot this symptom. In other problems you may receive other diagrams to which you can refer.

On your right is a board with a number of round pegs inserted in it. This is called a units board. In each problem the units board, or boards - there may be more than one - will list sections or components from which you must select the section or component which is defective and is causing the symptom.

With respect to the problem your job is to determine whether it is the local oscillator (examiner points to unit 1), the crystal mixer (examiner points to unit 2), the I.F. stage (examiner points to unit 3), or one of the remaining stages which is responsible for the symptom.

We will return to the units board in a moment but first look at the two boards in the middle, the boards with the rectangular blocks. These are called check boards. These check boards list a series of checks that a technician might want to make if he were actually working on the equipment. For example, you might want to check the D.C. Voltages (examiner points to check A), or the Crystal Mixer Current (examiner points to check B), or you might want to observe the waveform appearing at the output of the video detector (examiner points to C-1). The information that would be obtained if these checks were performed on actual equipment is presented under the rectangular blocks. For example, if you lift this block (examiner points to A) you find out what the output of the plus and minus 200 volt supplies are, and also what the difference voltage is. If you lift this block (examiner points to B) you are informed what the crystal mixer current is. If you lift this block (examiner points to C-1) you see the waveform you would actually see if you were observing the video detector output with an oscillo-synchroscope.

In other words, the check boards enable you to get the same information, by lifting one of the blocks, that you would get by performing a check on a missile which had the malfunction described on the symptom card.

So far, we have described the functions of the symptom card, the check boards, and the units board. Here are more specific instructions about how we can proceed to solve one of these trouble-shooting problems. Start by reading the symptom carefully; make sure to understand it as fully as you can. Then look over the checks and units that are presented in the problem. Now lift the block from the first check you think it necessary to make in order to determine which of the units is the defective one. Study the

results of this check and then, if necessary, proceed to perform whatever combination of checks you think necessary to identify the defective unit. The fewer blocks you lift the better will be your test score. When you have decided that you have performed enough checks to identify the defective unit, lift the round peg (examiner points to one or more of the units pegs) from the unit which corresponds to your choice. If you are correct you will find the word YES under the peg. If you are incorrect you will find the word NO. Obviously all the pegs except one have the word NO under them. If you pull the peg which has YES under it, the problem is solved. If you pull a peg which says NO under it, you have not yet solved the problem and you must continue to perform checks or pull units until you find the unit marked YES. You are always free, however, to perform any check or pull any unit that you want.

Your score on the test is computed by adding up the total number of checks and units you lift before getting to the correct unit. As in a game of golf the lower score is the better score; that is, the fewer checks and units lifted the more efficiently you have solved the problem.

Do not pull unit pegs unless you have enough check information to make a reasonable choice; you are penalized more heavily for pulling incorrect units than for making checks, so if you are not sure you have the right answer you are better off if you perform checks rather than pull units.

In summary, what you have to do in all the problems in this test is as follows:

1. Carefully read the sympton until you are sure you fully understand what it says.

2. Look at the check and units boards and decide which checks you want to make.

3. After you have performed a sufficient number of checks and think that you know which unit might be defective, pull the round peg from that unit. If the word YES is under the peg the problem is solved. If the word NO is under the peg continue to perform checks, or to pull units, in any order you want until you find the unit which has the word YES next to it.

4. Remember that the fewer checks you perform and the fewer units you pull before locating the defective unit, the better your score will be. Also remember that you are penalized more for pulling an incorrect unit than for performing a check.

While you are taking the test, I will record all the checks you perform and all the units you pull. Now go ahead and work the first problem.

# APPENDIX D

## TECHNICAL NOTE: SCORING TROUBLE-SHOOTING TEST ITEMS BY MEASURING INFORMATION

## APPENDIX D

## TECHNICAL NOTE: SCORING TROUBLE-SHOOTING TEST ITEMS BY MEASURING INFORMATION[1]

The primary purpose of this technical note is to indicate how the measure of information developed by Shannon[2] offers a rational basis for scoring the trouble-shooting formboard. The trouble-shooting formboard technique is described in chapter 2 of this report. The reading of this chapter should precede the reading of this technical note.

At the outset the analogy between communication and testing employed in this presentation should be made clear. Other analogies are possible; the one presented here is most suitable for the present purpose. The communication process as described by Shannon consists of an information source, a transmitter, a channel, a receiver, and a destination.

In proficiency measurement and achievement testing, the test constructor acts as the source, selecting the test items to be used. In their original form, these items are merely statements of fact:

One plus one equals two.

The transmission process involves encoding this statement by putting it into multiple-choice form:

One plus one equals:

A) Two

B) Log $e^3$

C) Seven decibels

D) Arc sin 1

---

1 This appendix was written by Robert Glaser and Paul A. Schwarz of the American Institute for Research.

2 Shannon, C. E. and Weaver, W. *The mathematical theory of communication.* The University of Illinois Press: Urbana, Illinois, 1949.

The test serves as the channel, while the subject acts as the receiver, trying to restore the original statement or fact. The choice he indicates on the answer sheet is the destination. In a standard multiple-choice item the examinee supplies information primarily on the basis of his own knowledge or understanding. In a formboard item the examinee is required to obtain the necessary information from the test itself. A score on a trouble-shooting formboard item should indicate the examinee's proficiency in doing this, i.e., his ability to obtain and apply information.

A quantitative measure may be applied to this process. The tester compiles statements of facts. By putting them in multiple-choice form he associates with each statement an "uncertainty", since now a choice has to be made by the examinee to arrive at the original statement. The amount of uncertainty associated with each statement will depend upon the number of possible choices introduced. There is, for example, more uncertainty associated with a situation where one of twenty possibilities is to be chosen than there is when the choice is between only two alternatives. More information is required to make the correct choice in the twenty-choice situation than in the two-choice situation.

The quantitative measure of the amount of uncertainty (from Shannon) associated with a multiple choice situation is given by

$$H = -\Sigma p_i \log_2 p_i \qquad [1]$$

Where $p_i$ is the probability of the $i^{th}$ choice being selected, and the i's range over all possible choices. The premise can be made that the amount of information an examinee must use in the decoding operation is exactly equal to the amount of uncertainty introduced by the tester in encoding. Thus, expression [1] is also a measure of the bits of information needed to restore the original message. For true-false items this value is one bit; for a four-choice item, two bits; for an eight-choice item, three bits, etc.

These values were derived from formula [1] by assuming the probabilities of the choices to be equal. In the true-false case the $p_i$'s were equal to one-half; in the four-choice, to one-fourth; in an eight-choice, to one-eighth. The following argument can be presented for the acceptance of this assumption. Suppose a test is administered in which the choices are not presented to the subject, though the examiner knows them:

One plus one equals:

A)
B)
C)
D)

The probability that the subject will get the correct answer, choosing at random, is obviously one-fourth, and the choices are equiprobable. It may be argued that when the actual choices are given, this equality is disturbed. Thus, in our previous example "seven decibels", involving numbers and units, may be considered a far more ridiculous choice than any of the others. But this decision is not part of the a priori probability. It is made by the subject in the decoding process, and requires some information input on his part.

Suppose a formboard item with four possible unit choices is constructed, i.e., there are four possibly defective units to choose from, one of which is defective. The examinee lifts a number of check blocks, observes the results of these procedures and then pulls a unit peg. If he sees the word "NO" he continues pulling check-blocks and/or unit pegs; if the word is "YES" he goes on to a new problem. Efficiency of problem solving, in this context, may be operationally defined as the amount of information obtained per check procedure. A measure of this can be expressed by determining the amount of information an examinee applies in arriving at the defective unit and dividing this quantity by the total number of check blocks lifted.

A rationale for the computation of the numerator of this measure, the amount of information the examinee applies in arriving at the defective unit can be presented as follows: as previously indicated a four-choice item contains two bits of uncertainty. If the examinee makes the correct choice on his first try, he has applied (and therefore obtained) two bits of information and is credited with that amount. If he makes an incorrect choice, and chooses again, he is then faced with only three possibilities. What has happened is that the tester, by informing the examinee of his error, has reduced the uncertainty of the problem situation. The tester has, in effect, applied the information originally available to the examinee to apply in choosing between two alternatives--the rejected answer (probability one-fourth), and the three remaining ones (probability three-fourths). Hence the information the tester has applied on the first choice is given by:

$$H_1 = -[1/4 \log 1/4 + 3/4 \log 3/4]$$

$$\text{or } H_1 = .81$$

After a first incorrect choice, therefore, the examinee is left with a situation that requires 2 minus the .81 bits applied by tester or 1.19 bits of information. If he chooses correctly now, he has applied that amount of information.

Similarly, the information associated with the remaining three choices and the two choice situation which may occur can be determined. The final expansion is:

$$H = -[(1/4 \log 1/4 + 3/4 \log 3/4)_1 + 3/4\ (1/3 \log 1/3 + 2/3 \log 2/3)_2 + 1/2\ (1/2 \log 1/2 + 1/2 \log 1/2)_3]$$

(where 3/4 and 1/2 outside the parentheses are weighting factors given by the probability of the second and third choices occurring, respectively)

$$\text{or } H = .81 + .69 + .50$$

If the examinee chooses incorrectly on his second try and must choose again, he may earn 1.19 minus .69 or .50 bits. If all four unit choices are selected the examinee has effectively applied zero or no information.

A trouble-shooting formboard item score, according to the scoring technique previously described, consists of this measure of the amount of information applied by the examinee divided by the total number of check blocks lifted. This ratio yields the amount of information obtained per check procedure.

In trouble-shooting situations where the performance of certain check procedures is costly, harmful or inordinately time-consuming, it is possible to assign weights to the different checks in an item on the basis of their "costliness". A more costly procedure would secure more weight than a less costly one; the choice of a more costly procedure would weight more heavily the denominator of the scoring ratio and decrease the magnitude of the score.

In summary, it should be pointed out that the scoring model described here involves the following assumptions and limitations:

1. The more possibly defective units involved in a trouble-shooting situation, the more information required to locate the defective unit. Hence, items with more possible solutions have a larger H value and receive more weight in the total test score.

2. Before a trouble-shooting problem situation is presented to an examinee, his choices of alternate units are equiprobable.

The scores obtained from the procedure discussed here will probably correlate highly with simpler scoring methods. However, the application of a formal model, like information theory, not only affords a logical basis for a scoring procedure, but also facilitates the analysis of trouble-shooting methods for the improvement of training and on-the-job performance.